THE WATER RESOURCES BUREAU
THE AFAR NATIONAL REGIONAL STATE
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

No.

BASIC DESIGN STUDY REPORT

ON

THE PROJECT FOR WATER SUPPLY DEVELOPMENT

IN THE AFAR NATIONAL REGIONAL STATE

IN

THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

JULY 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

KYOWA ENGINEERING CONSULTANTS CO., LTD.
YACHIYO ENGINEERING CO., LTD.

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PREFACE

In response to the request from the Government of the Federal Democratic Republic of Ethiopia, the Government of Japan decided to conduct a basic design study on the Project for Water Supply Development in the Afar National Regional State and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Ethiopia a study team from January 5 to May 10, 2006.

The team held discussions with the officials concerned of the Government of Ethiopia, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Ethiopia in order to discuss a draft basic desing, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the government of Ethiopia for their close cooperation extended to the teams.

July, 2006

Masafumi Kuroki

Vice President

Japan International Cooperation Agency

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Water Supply Development in the Afar National Regional State in the Federal Democratic Republic of Ethiopia.

This stud was conducted by the joint venture between Kyowa Engineering Consultant Co., Ltd. and Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from January to July, 2006. In conducting study, We have examined the feasibility and rationale of the project with due consideration to the present situation of Ethiopia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

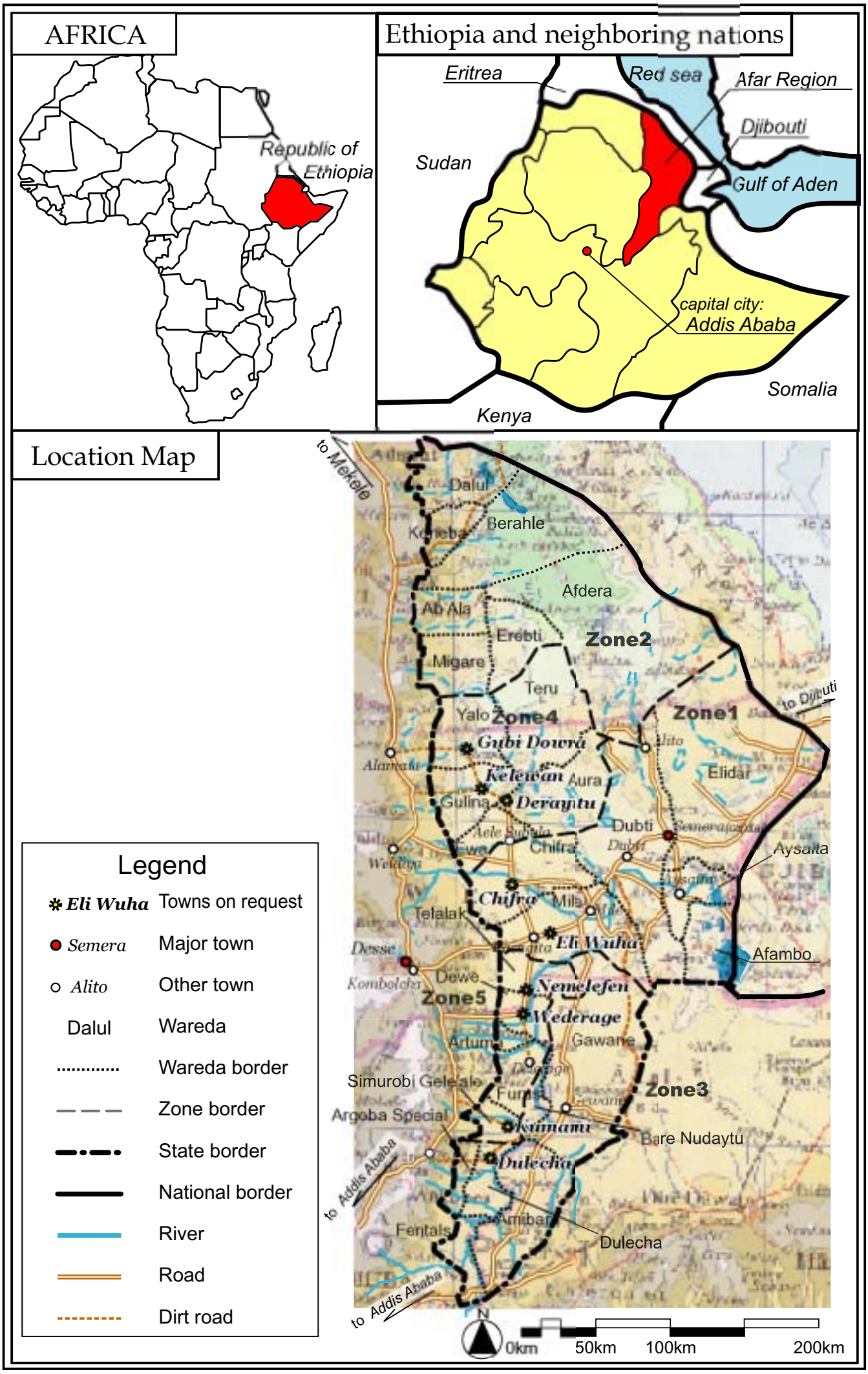
Masayuki Taguchi

Chief Consultant

Basic design study team on

Project for Water Supply Development in Afar National Regional State

Joint venture between
Kyowa Engineering Consultants Co., Ltd. and
Yachiyo Engineering Co., Ltd.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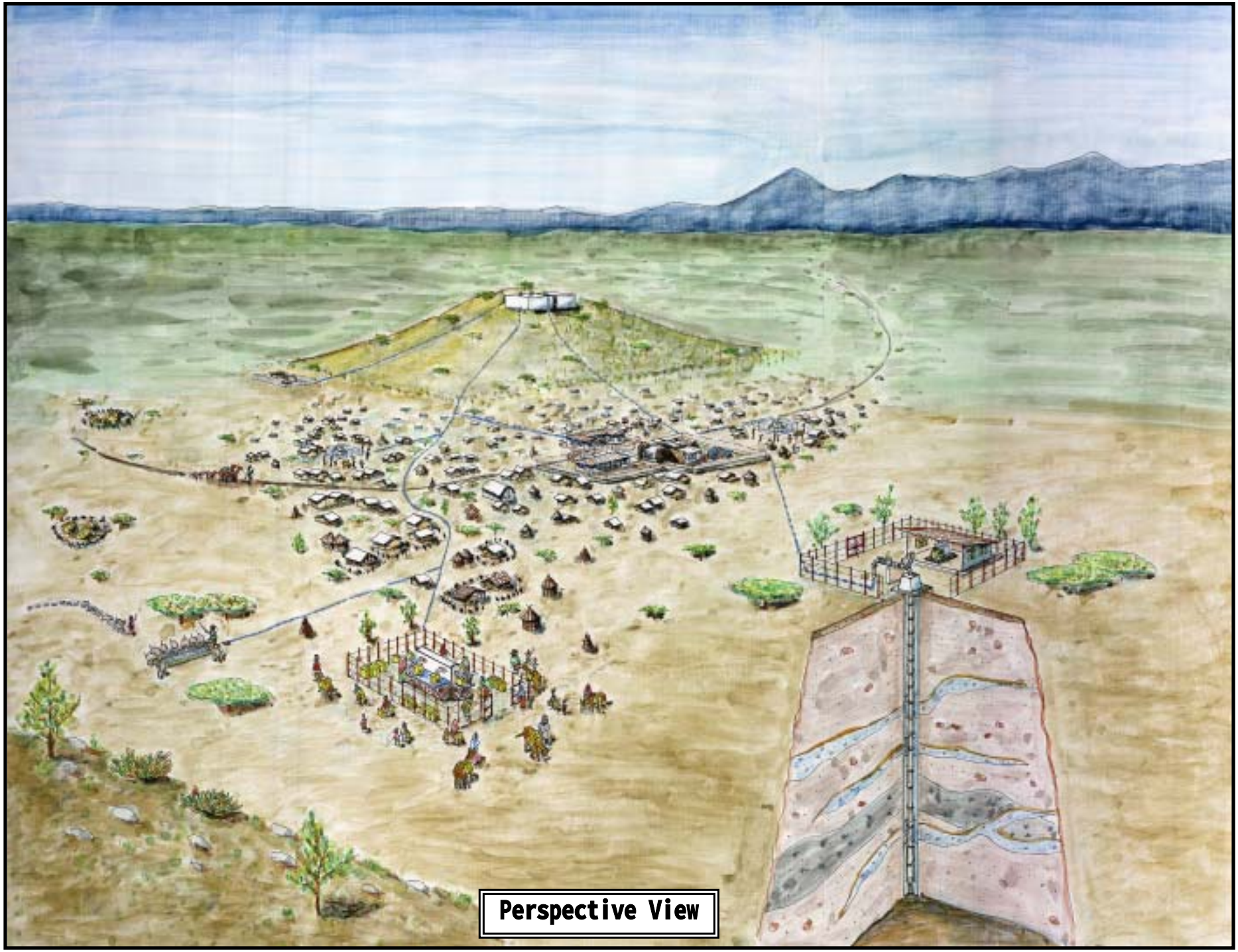
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List of Abbreviations

AWRB	: Water Resources Bureau of Afar National Regional State
DDMS	: Designed Daily Average Supply Water
EIA	: Environmental Impact Assessment
EPA	: Environmental Protection Agency
GDI	: Gross National Income
HIV/AID	: Human immunodeficiency virus/ Acquired immune deficiency syndrome
JICA	: Japan International Cooperation Agency
JIS	: Japan International Standard
MDG	: Millennium Development Goal
MoWR	: Ministry of Water Resource
ODA	: Official Development Assistance
OJT	: On-the -job-training
O&M	: Operation and Maintenance
PDM	: Project Design Matrix
PLD	: Payload
PVC	: Polyvinyl Chloride
SDPRP	: Sustainable Development and Poverty Reduction Program
TDS	: Total Dissolved Solid
UAP	: Universal Access Program
UN	: United Nations
UNDP	: United Nations Development Program
WRO	: Water Resource Office
WSDP	: Water Sector Development Program
WSO	: Water & Sanitation Office (Ex Water Desk)

SUMMARY

Summary

The Federal Democratic Republic of Ethiopia (hereinafter referred as "Ethiopia") is located at so called “the Horn of Africa” in the eastern Africa. Ethiopia is the landlocked country surrounded by Eritrea, Djibouti, Kenya, Sudan, has an area of 1,097 million km^2, 68.6 millions of population, 6.2 billion dollars of Gross National Income (GNI), and 90 dollars on GNI per capita (World bank, 2003).

Its economy had been sluggish due to the conflict with Eritrea over a period of 17 years and the repeated heavy droughts. The signs of economic recovery were shown in 1995, then, it has proceeded to a stable growing stage. However, such conflict and drought produced a mass of evacuees and refugees and have been burdens on development of the economy. The Ethiopian Government had elaborated “the 2nd five-year national development plan (2000-2005)” in 2000, and “Sustainable Development and Poverty Reduction Program”(referred as SDPRP) in 2002, for stabilization of the economy. Development of the water sector is focused as one of the most important issues in the national policy and "Water Sector Development Program 2001-2015 (WSDP2001-2015)", in which water resources development is targeted for poverty reduction and sustainable development, was enacted in the central government. Regarding “Millennium Development Goals (MDGs)” addressed by UN, the Government has been making an effort to develop the water supply coverage to 100% by 2012 under the “Universal Access Program (UAP) ”.

In Ethiopia, it is estimated that about 24 % of the population can access to safe potable water. This figure is quite lower than the average of countries of Sub-Sahara (54%) estimated by United Nations of Development Program (UNDP). People in the rural area, where 85% of total population of Ethiopia lives, spend a lot of time and manpower to fetch potable water, and it causes acceleration of the poverty in the area. Especially, water shortage caused by frequent droughts influences both the society and the economy of Ethiopia seriously. For these reasons, potable water supply is one of the urgent issues to be attended for upgrading fundamental education, health and medical, and rural development in the country.

The Japanese government has been in cooperating with the Ethiopian government in the water sector from the 1990s. In recent years, the Japanese government has focused on the capacity building of human resource of the regional state government in the field of groundwater development and water supply, as the management of waterworks has been transferred from the central government to the regional state governments due to the decentralization commenced in 1994.

The Afar State, which has about 1.27 million population and 92,371 km^2 in area, is located in the northeast of Addis Ababa and in the northwest of the Great Rift Valley. Average water supply coverage in the Afar state was only 16.5% against the same of the national level 30.9% in 2001. WSDP aims to improve the water supply coverage in the Afar state from 44%(urban) and 14%(rural) in 2001 up to 90%(urban) and 62%(rural), in average 65.1% by 2016.

Under such circumstances, the Ethiopian Government made a request of grant aid for “the project for water

supply in rural area in the Afar State" to the Japanese Government in 2001 through the Ministry of Federal Economic and Development. In response to the request, the Japanese Government entrusted the Japan International Cooperation Agency (JICA), the official agency in charge of implementing technical assistance and expediting proper execution of the Japan's Grant Aid, to carry out a study. Hence, in November 2001, JICA carried out a preparatory study and verified the necessity, eligibility, and urgency for implementing a basic design study for the request.

However, the project sites are changed due to the improbability of groundwater potential of the sites. The Water Resources Bureau in the Afar Regional State (AWRB), the implementation agency of the project, prepared and submitted new proposal to the Japanese Government. The revised proposal has three components:

1) The improvement of water supply coverage in proposed 9 towns of Gubi Dowra, Kelewan, Deraiytu, Chifra, Eli Wuha, Nemelefen, Wederage, Kumami, and Dulecha,
2) The procurement of the equipment for well maintenance, and
3) The capacity building of AWRB's staff.

Consequently, the Japanese Government has decided to carry out the Basic Design Study to establish an appropriate project component for the revised component of the Project, and JICA dispatched a Basic Design Study Team to Ethiopia from 5 January to 10 May 2006. The Study Team carried out discussions with the parties concerned, the field survey, and collecting of relevant data during their stay in Ethiopia.

Not only technical survey but also socio-economic survey was carried out in field survey. Stakeholders' meeting was held in 9 proposed sites to grasp the real needs and the difficulties for the Project in addition to sample household survey. Groundwater verification study was carried out to grasp the groundwater potential on quantity and quality in the Project sites. Geoelectric survey was carries out in 9 towns, and test well drilling was carried out in 7 towns on the basis of the result of geoelectric survey. Through those surveys, the Study Team obtained the necessary data and information for the justification of the Project.

After returning to Japan, the Study Team analyzed the justification of the Project, the appropriate project components and scales, and the necessity of technical assistance, etc. As a result of the data analysis, the project component, consists of following three components, was designed as per the request from the Government of Ethiopia.

1) The construction of water supply facilities
2) The procurement of equipment
3) The capacity building (Soft Component)

JICA again dispatched the Study Team to Ethiopia from 4 June to 14 June 2006 to explain and discuss on the project component described in a draft basic design report. A series of discussions on the project component, the undertakings of both countries, important issues for the project implementation, etc. were made between the Study Team and Ethiopian Side, and the both side agreed basically on the total scope of the basic design report.

The water demand for the designing water supply facilities was targeted at the year of 2010 along with the policy on Japan's grant aid system. The existing facilities such as wells, reservoirs, pipelines, etc. are considered to be utilized basically as it is, if those are evaluated enduarable to use continuously from the points of designed capacity and mechanical reliability.

The equipment to be procured in this Project was chosen in considerations of a plan of rehabilitation work, the equipment presently owned, and technical capability on well rehabilitation of AWRB. A cargo truck with crane has proposed instead of service rig from the aspect of well rehabilitation method that ARWB aims, and the equipment necessary for the pumping test has been selected as per the request. Concerning mobile workshop, AWRB already has a same type of equipment, and it is judged that O&M work can be carried out by it. For this reason, mobile workshop was excluded from the Project component.

The following technical assistances were proposed, based on current situation on AWRB's well rehabilitation plan and water supply service performed by Water Committees and Water Desks in the Project sites.

1) Improvement of the technical skill related to well rehabilitation technique
2) Improement of the managerial skill related to water supply service

The comparison between the original request and finalized component of the Project is summarized in Table 1. In addition, the details of the water supply facilities to be constructed and the equipment to be procured in this Project are summarized in Table 2 and 3.

Table 1 Comparisons of Original request and Component of Japanese Assistances

Item	Original Request	Component of Japanese Assistant	Remarks
Target Area	9 towns in Afar region	Ditto	8 towns are Woreda centers
Facilities Construction	Expansion and Rehabilitation of the existing water supply facilities (Well, Service reservoir, Pipelines, Public faucets, rehabilitation of the existing well, etc.)	Construction of water supply facilities for the project target year 2010 (Same kinds of facilities)	
Equipment Procurement	・A set of well maintenance service rig with accessories ・A set of track mount mobile work shop equipped with machinery and tools	Equipment of well rehabilitation ・A truck with well rehabilitation equipment ・A truck with pumping test equipment	As a supplement procurement for insufficiency of the existing equipment.
Technical Assistant	Raising up management capacity of water supply facilities for staff of AWRB and Woreda Water Desks	Soft Component Program ・Improvement on Well rehabilitation technique ・Improvement on managerial capabilities of water supply services	

Table 2 Contents of Facility Construction

Item	Contents	Number	Remarks
Water source facility	Reuse of test wells as production wells	6 wells	Test wells was constructed in the basic design study Phase
	Construction of new deep wells	6 wells	
	Rehabilitation of existing wells	3 wells	Work will be implemented by soft component program
	Well pump and electric generator	12 sets	
	Electric generator room	12 sets	
Water supply facility	Pipe line: φ50mm to φ75mm	21,280 m	
Water distribution facility	Distribution reservoir ; 50m^3 to 130m^3 Elevated water tank ; 50m^3, H=6m	6sets 1set	
	Pipe line φ50mm to φ100mm, (include incidental facilities)	19,740 m	
	Public water tap Public drinking fountain for live stock	28 sets 1 set	

Table 3 Contents of Procurement of Equipment

Item	Specifications	Number	Remarks
Well rehabilitation equipment with related accessories	Cargo truck with 3ton crane, PLD10ton	1set	For well development
	Equipment and tools for well development	1set	-do-
	Cargo truck with 3ton crane, PLD6ton	1set	For pumping test
	Submersible pump (2units), Generator	1set	-do-
Survey equipment	Water quality analysis kit	1set	

After the conclusion of the Exchange of Notes between two countries of Ethiopia and Japan for the implementation of the Project, the periods of the Detailed Design for the Project are estimated at 8 months, 4 months and 15.5 months respectively. Concerning the soft component, it takes 4.2 months to carry out.

Total project cost is estimated roughly at 596 millions Japanese Yen. As a breakdown of this cost, the Japanese side covers 578 millions Japanese and the cost to be born by the Ethiopian side is estimated at 18 millions Japanese Yen (equivalent to Ethiopian Birr 1.34 millions). This cost estimate is provisional and would be further examined by the Government of Japan for the approval of the Grant.

On completion of the Project, total water supply volume for the nine target towns will be increased to 1,702 m^3/day on the daily maximum supply basis in the project target year 2010 from 408 m^3/day actually surveyed in 2006. And the water service population will also be increased to 34,350 in 2010 from 16,320, which was estimated by dividing the total supply volume by 25 L/day per capita, the assumed unit consumption, in 2006. Water coverage ratio will be similarly improved from 49.4% to 75.6% in the target towns.

Indirect effects of the Project are expected as follows:

- Quality water can be supplied stably and the water-born diseases such as diarrhea, intestinal parasite, malaria, typhoid, etc. will be decreased.
- Women will be more encouraged to participate in the social activities and have chances of employment, and the children can have more chances of education due to alleviation of water fetching work from them.

Effects of implementation of the Soft Component:

- Well rehabilitation skills will be enhanced, and then AWRB can implement the relevant scheme by itself.
- Management skill and know-how will be reinforced in Water Committee.
- Managing capacity for Community participation based Operation and Maintenance (O&M) of water supply facilities will be transferred to the officers of Water & Sanitation Office (WSO) in Woreda.

Effects of the Equipment Procurement:

- Rehabilitation for wells with more than 100m deep can be implemented by AWRB.
- Efficiency of groundwater utility will be increased by a sound progress of the Well Rehabilitation Scheme to be managed by AWRB.

Basic Design Report

Contents

CHAPTER 1. BACKGROUND OF THE PROJECT

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1-1 Background of the Study

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1-2 Situation of the Project Sites

1-2-1 Location of the Project Sites

The Afar regional state is located in the northeast of Addis Ababa and in the northwest of so called the Great Rift Valley. The state is classified into an arid climate, where the mean annual rainfall is under 150 mm. The Project sites are 9 towns including 8 Woreda towns and a key town of local traffic. Those towns are located in a range of about 300 km stretches north and south along the western state border and topographically between the highland to the low land. And elevations of these towns are between 650 m and 1000 m above see leves.

Table1.2.1 Project Sites and Problems of Water Supply Facilities

Town	Woreda	Current Population	*)Priority for development	Problems
1) Gubi Dowra	Yalo	1,500	2	Water shortage, Bad quality (high mineral content)
2) Kelewan	Gulina	4,650	8	Water shortage
3) Derayitu	Aura	3,650	3	Shutdown of water supply by well trouble
4) Chifra	Chifra	6,510	5	Less pressure
5) Eli Wuha	Mille	5,400	7	Less pressure
6) Nemelefen	Telalak	3,150	4	Bad quality (high salinity)
7) Wederage	Dewe	3,450	6	Water shortage
8) Kumami	Simi Robi	2,350	1	No water facilities, Dependent on external water vendor
9) Dulecha	Dulecha	2,400	9	Water shortage
Total		33,060		

*) Orders of the Priority were given by the Ethiopian side.

1-2-2 Socio-economic Condition of the Study Area

As for the target 9 towns, availability of accurate statistical data is limited. Stakeholder meetings and social surveys through interviewing the town administrators and inhabitants were implemented in order to supplement this limitation of the statistical data. Survey methods and results are summarized as follows.

(1) Survey methods:

【Socio-economic Profile Interview】

Structured interviews using questionnaires were carried out in order to collect information on development and history of the towns and demography. Interviewees of the survey on socio-economic profile were about 10 persons such as Woreda Administrators and Community leaders at respective towns.

【Stakeholder Meeting】

Participants of the meetings were about 20-30 community leaders (such as Water Committee, Women Groups, Youth Groups), and Woreda Administrators (such as Staff of Water Desk, Pastoralist Development Department and other key offices). With these participants, ①Stakeholder Analysis, ②Problems Analysis and ③Objective Analysis were carried out in order.

【Sample Household Survey】

Ten households were selected at each town, and structured interview using the questionnaire was carried out to the 10 sampled households at the 9 target towns. Main respondents of the household survey were housewives, who are primal caretakers of domestic water and consumptions of it at the household level. Husbands were also requested to answer as the secondary interviewees at each household. Major questions of the sampled household survey were:

① General information of the households (family size, occupation and income sources, schooling status/literacy of the family members, income/expenditure etc.)

② Water use and water related information (main water sources by seasons and by purposes, satisfaction to the existing water sources, time and frequency to fetch water, participation and satisfaction to the water committee, water fee, needs for water improvement etc.)

③ Health related information (major diseases, availability of latrines/bath facility, practice of boiling water, needs for health/sanitation improvement etc.)

(2) Development of the Target Towns

Among the 9 target towns, Eli Wuha Town was originally developed as a camp for the road construction about 75 years ago, and Dulecha was naturally formulated in 1950s. On the other hand, other 7 towns have been politically constructed as administration and political units after 1990s. While majority of the general

inhabitants are the Afar, majority of government employees and merchants/business persons are the non-Afar and from other ethnic groups. These non-Afar people are mainly public employees or small-scale merchants/business persons living in the center part of the towns. It is likely seen that economic advantages and benefits along with economic and infrastructure development of the towns have been enjoyed more by the non-Afar population than that to the Afar people. It is expected that as infrastructure development in and around the towns further is advanced, more number of the non-Afar population would move into the 9 towns from the neighboring regions.

(3) Demographic Information

As mentioned previously, the 7 towns among the target 9 towns were developed late as administrative units. Statistics of these 7 towns are thus not fully available in the Census of 1996. According to the hearing to the administrators and community leaders, population of the last decades has generally been increasing. However, it is responded that in case of Kelewan town, number of commercial and administrative persons are decreasing because the function of the Zonal centre has been diminished in accordance with progress of the decentralization policy.

Seasonal changes of the population are not very significant excepting for Eli Wuha town, where there is no alternative water source in its surrounding area. In case of Eli Wuha where the town has longer history more than 60 years, major reason for influx and settlement of the pastoralists are better educational chance for their children. This reason of influx and settlement of the pastoralists has been, in a sense, contributing development of the town. According to the public administrators and community leaders, there are not much favorable pasture land in and around the 9 towns, therefore the pastoralists prefer to move to other regions during the dry season in order to feed good grass to their livestock. While there are many pastoralists, who visit temporarily to the town in dry season, the reason of the visit is to receive the food aids. The temporal visit of the pastoralist is thus not a major contributing factor for increasing demands of water supply in the 9 towns.

As aforementioned, predominant ethnic group is the Afar (70-90%) while there are significant numbers of Amharic and Oromian people, in particular, those who are engaging commercial activities and public employment in the 9 towns. In most of the towns respondents to the socio-economic profile interviews answered that recent shortage of water has been caused and worsened by increase in populations, in particular those who moved into the town seeking advantages of increasing economic chances and functions of the town.

(4) Socio-economic Background and Gender Issues

According to the results of the socio-economic profile interview, over 70% of the inhabitants in the 9 towns are the Muslim. Because of the religion and traditional-social practices, women's workload is heavy as most of the domestic works even including household construction are regarded as women's task. On the other hand, men's duty is generally limited to caring livestock nowadays. In the stakeholder meetings, it is commonly pointed out in all 9 towns that 'women and children are the most affected groups by the

current water supply situations since fetching and securing domestic water is women's task. In the stakeholder meetings at the target 9 towns, ideas that "there are close relations between improvement of women's living conditions and water supply" was strongly supported by male participants too.

(5) Economic Activities

In the 9 target towns, major economic activities are animal husbandry and small scale commercial in common. According to the sampled household survey in the 9 target towns, 37% of respondents engage themselves in raising animals, 32% in small commercial and 24% are government employees as their means of their livelihood (refer the detailed information in the appendix). There are some households cultivating agricultural crops such as maize and sorghum in Chifra, Nemelefen and Dulecha (totally about 20 households in these 3 towns). Cropping has not been practiced in other 6 towns, and inhabitants of these 6 towns in general receive food aid, such as cereal and cooking oil. Particularly, in Kelewan, dependency to food aid is higher and most of all town inhabitants rely on provision of food aid nearly 100%. In the 9 towns, camel, goat, sheep and cow are regarded most important animals to the inhabitants.

(6) Economic (Income) Status of the Target Towns

According to results of the sample household surveys, average annual household income of the 9 towns is 4,433 Birr (=USD493 equivalent, Exchange rate: 1USD= 8.99Birr, as of April, 2006). This amount of annual income is higher than the one of national average (=USD110, World Bank, 2004). It is assumed that this relatively higher income level in the 9 target towns is due to higher chances of having samples of the regular income in the towns, where the government officials and merchant/business persons live. Most respondents of the sampled household surveys live in the middle of the town.

(7) Needs and Request of The Town Inhabitants for Water Supply

【Water Supply】

Excepting Kumami town, where there is no water source, in other 8 towns there have been water supply systems using public fountain in every town and yard connections in some towns. Duration of water supply per day varies from 3 to 11 hours depending on the town. Not only in Nemelefen and Wederage, where house connections were already installed partly, yard connection was requested strongly in all the 9 towns. Especially, in the town where water supply facility has been out of order, economic burdens of the inhabitants for purchasing water from vendor are high, and the inhabitants are eager to install their yard connections for their convenience. It is, however, necessary to note that the inhabitants, who are requesting yard connection, would not afford the construction cost of the private connection.

【Operation of the Water Supply】

In most of the towns, water committees were established, and the water supply facilities and the public fountain have been operated and maintained by Water Committees. On the other hand, there are some

committees that activities have been stopped due to inability of responding to damages of well pumps and public fountain. According to the result of the sample household interview, degree of the inhabitants' satisfaction to Water Committees is low in general. Reasons pointed out for dissatisfaction were: ①inconvenient water supply due to limited operation hours, ② insufficient capacity of financial management, and ③ insufficient capacity of physical facility management. In Dulecha, while there is no Water Committee, a women group has been playing the same role of water committee in terms of operation and management of water supply facilities, and it is found that the satisfaction of the users to the role of water supply management is higher than other towns.

【Water Tariff】

Current water tariff is from 10 cents to 30 cents per 25 liter, and exemption and discount for low-income facilities are practiced in some towns. According to the sample household survey, majority of respondents answered that range of capacity to pay is above 20 Birr per household while above 15 Birr was in Chifra and Wederage.

The results of socio-economic surveys are summarized in Table 1.2.2. (for more details see in the appendix)

Table 1.2.2 Summary of the Socio-economic Surveys (i)

Name of Town	Gubi Dorwa	Kelewan	Derayitu	Chifra	Eli Wuha	Nemelefen	Wederage	Kumami	Dulecha
Function Status of Water Supply Facilities	Functioning	All communal taps are functioning. There are many private connections.	All private and communal taps had not been functioning (A new pump was planned to be installed in January 2006)	2 communal taps are operational while 4 taps are out of order.	3 communal taps are operational while 1 has been broken since 2005.	1 tap for a school has been functional while the other 3 are not functional. The inhabitants buy water from neighbors' private taps.	2 communal taps are functional. But the inhabitants prefer buy water from the neighbors' private taps due to distance to communal taps.	No protected water source. Most villagers buy water from the vendor from Shoa Rob Town.	All 3 are functioning, but only one tap is open 1 time since only 1 collector hired by the WC. Many inhabitant complain the limited opening time.
Timing of Water Supply (at WS outlet)	Not regular	8:00-11:00, 16:00-18:00 (5 hrs)	Currently no water supply (due to a broken pump)	9:00-12:00 or 13:00 (3 or 4hrs)	7:00-11:00 (4 hrs)	6:00-18:00 (11 hrs)	8:00-12:00, 16:00-18:00 (6 hrs)	_	7:00-9:00, 17:00-19:00 (4 hrs)
Request for Facility Improvement	①Private connection: 91%, ②Communal tap: 9%	①Communal tap: 60%, ②Private connection: 40%	①Private connection: 75%, ②Communal tap: 25%	①Private connection: 80%, ②Communal tap	①Private connection: 77%, ②Communal tap: 23%	①Private connection: 100%	①Private connection: 75%, ②Communal tap: 25%	①Private connection: 75%, ②Communal tap: 25%	①Private connection: 92%, ②Communal tap
Status of Water Committee	1 WC	1 WC but not active and activities were stopped. Therefore Woreda Water Desk directly controls water supply management at this moment.	1 WC (hiring 1 pump operator & 1 tap attendant)	2 WCs (hiring pump operator, tap supervisors, mechanic)	1 WC (hiring pump operator and collector)	Not functioning	1 WC, but not active.	1 WC was present, but not active after ceasing free water distribution.	1 active WC operated by the Women Group. The WG does good financial management.
Satisfaction to Existing Water Committee	Satiesfied:100%	Not satisfied: 60%, satisfied：40%	Not satisfied：100%	Not satisfied: 82%	Not satisfied：more than 90%	In the past 50% were not satisfied.	Not satisfied: 83%, satisfied：17%	Activities of water committee is stopped currently.	Satisfied: 75%, not satisfied：25%
Availability of Water Vendors	50 cents/L (for market day) form spring	None	50 cents/25L from river	50 cents/25L from private connection	25 cents/25L (some houses with household connection)	25 cents/25L (houses with private connection)	15 cents/20L, 20 cents/25L (houses with private connection)	Water brought from Shoa Robi Town (3 Birr/25L)	None
Water Fee Collected	25 cents/25L, 600 Birr/month	15 cents/20L, 20 cents/25L	25 cents/25L	30 cents/25L (raised in 2005), for piped fee is scheduled	10 cents/25L	Not functioning	15 cents/20L, 20 cents/25L,	No protected water source	25 cents/25L

Table 1.2.2 Summary of the Socio-economic Surveys (ii)

Name of Town	Gubi Dorwa	Kelewan	Derayitu	Chifra	Eli Wuha	Nemelefen	Wederage	Kumami	Dulecha
Capacity to Pay (Month)	More than 20 Birr /month: 40%, 5-10 Birr /month: 20%, more than 25 cents/25L bucket: 55%	More than 21-26 Birr /month: 60%, 6-15Birr /month: 20%, more than 15 cents/25L bucket: 70%	More than 26 Birr /month: 42%, 16-20 Birr /month: 25%, more than 15 cents/bucket: 83%	More than 15 Birr /month: 63%, 3.0-5.0 Birr /month: 18%, 20-25cents/bucket: 37%, 30-50 cents/bucket: 36%	25 cents/25L bucket: 73%, 30-50 cents/25L bucket: 18%	_	More than 15 Birr /month: 84%, more than 20 cents/25L bucket: 42%	More than 20 Birr /month: 92%, 15-20 Birr /month: 8%, 25 cents/25L bucket: 67%	_
Average Income (Year)	Birr 5,000 (USD556)	Birr 3,814 (USD424)	Birr 5,030 (USD560)	Birr 3,558 (USD396)	Birr 3,772 (USD420)	Birr 5,000 (USD556)	Birr 4,559 (USD507)	Birr 4,167 (USD464)	Birr 5,000 (USD556)
5% of HH Income (Average/Month) *1)	Birr21	Birr16	Birr21	Birr15	Birr16	Birr21	Birr19	Birr17	Birr21
Alternative Water Sources	Traditional wells, Pond, Spring	1 Shallow well (UNICEF) for an emergency case, River	River (2 hrs/round), Traditional wells in rainy seasons	River (throughout the year)	None	1 hand pump well by UNICEF (200-300m) , River (300m) , Spring along river	River	River	River
Needs for Water Supply Improvement **2)	1 Quantity, 2 Quality, 3 Convenience	Men: 1 Quality, 2 Quantity, 3 Convenience while Women: 1 Quantity, 2 Convenience, 3 Quality	Men: 1 Quality, 2 Quantity, 3 Convenience while Women: 1 Quantity, 2 Quality, 3 Convenience	1 Quantity, 2 Quality, 3 Convenience	Men: 1 Quality, 2 Quantity, 3 Convenience while Women: 1 Quantity, 2 Quality, 3 Convenience	1 Quality, 2 Convenience (distance), 3 Quantity	1 Quality, 2 Quantity, 3 Convenience	1 Quality, 2 Convenience, 3 Quantity	1 Quality, 2 Convenience, 3 Quantity
Volume of Water Uses/per Households for Domestic Use (Drinking, Cooking, Washing & Bathing, excluding for Animal Watering)	Range: 25L to 43L/person/day	Average 31.5L/person/day	Average: 39.5L/person/day	Average: 52L/person/day	Range: 22-27L/person/day	Range: Drinking & Cooking 16-25L/person/day (only for cooking and drinking, washing and bathing at river)	Range: 10-17L/person/day	Range: 20-38L/person/day (Washing and Bathing at river)	Range: 38-66L/person/day (Washing done at river)
Availability of Health Facilities and Private Latrines	Health centre, private latrine: almost none	Health centre, private latrine: 0	Health clinic, private latrine: 0	Health centre (2005), private pit latrine: some have	Dispensary, private latrine: some commercial families	Dispensary, private latrine: 0	Dispensary, private latrine: 10	Dispensary, private latrine: 0	Health centre, private latrine: 2-3
Major Diseases	Malaria, Ameba, Diarrheas, Respiratory	Malaria, Diarrheas, Dysentery, Respiratory, Pneumonia, Parasites	Malaria, Pneumonia, Respiratory, Typhoid, Ameba	Malaria, Diarrheas, Dysentery, Eye disease, Respiratory,	Malaria, TB, Eye disease, Diarrheas	Malaria, TB, Water borne diseases for children, kidney stones above age 30, Respiratory	Malaria, TB, Meningitis, Diarrheas, Measles	Diarrheas, TB, Pneumonia, Typhoid (Malaria is not significant)	Malaria, Pneumonia, Typhoid, Eye disease, Diarrheas

Note: * 1) Estimated based on 5% of the average monthly income

** 2) Convenience mainly means distance to the water supply facilities (communal taps)

1-2-3 Current Status of the Existing Water Supply Facilities

The target towns of the study have a water supply system except for Kumami Town. The existing systems in Project sites basically consist of intake facility (deepwell), transmission facility, and distribution facility. Concerning the service mode of water supply in the project sites, there are following two types currently; 1) type of only public fountain or 2) type of both public fountain and yard connection. The public fountain users are majority, but however, the number of yard connection user is gradually increasing.

Most of data on the existing wells such as static and dynamic groundwater levels, pumpage, etc. was not prepared as the written document at the construction stage in the project site. For this reason, the appraisal of the existing wells was made by the on-the-spot-observation and the interview to the personnel concerned in each town.

The current status and the problem of the existing water supply systems in the project sites are summarized respectively in blow.

(1) Gubi Dowra Town

The layout of the existing water supply facilities is as shown in Fig. 1.2.1. Currently, water supply is made through only one public fountain, and operational hour of well pump has been extremely limited due to the storage capacity of the existing elevated tank.

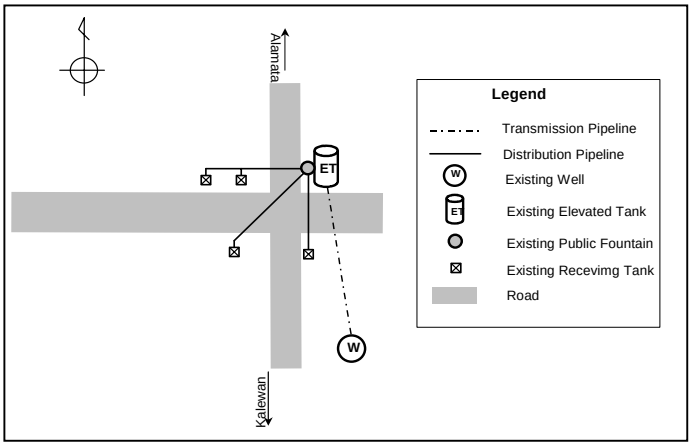


Fig. 1.2.1 Layout of Existing Facilities of Gubi Dowra

For this reason, the inhabitants usually line up for receiving the water before the working hour of the public fountain. And people queue up more than 20m lengths sometimes in front of the public fountain. The current status and the problem of the existing facilities are summarized as follows.

Intake facility (deepwell) including pump and transmission pipeline	The existing well was constructed by Tigray WWCE before about 10 years. The appraisal of the well yield cannot be made, because any data related to the existing well is unavailable. Mono-pump is installed to withdraw the groundwater, and the current pumpage was measured at 2.8L/sec. Water leakage was seen around pump shaft, and it is judged that the existing pump is almost out of use. As a result of the water quality analysis, the groundwater has rich dissolved minerals and high temperature that is affected by the volcanic activity. For this reason, it is necessary to consider this water condition for decision in the technical specification of pump.
Distribution Facilities	The capacity of the elevated tank is 4 m^3 equivalent to about two hours of the maximum day demand of the current population, and it cannot distribute the water to the whole town with necessary pressure. For this reason, it is necessary to build new reservoir at right place that is with enough elevation to distribute the water. There is only one public fountain in the town, and distribution pipeline to some town offices is only installed. For these reasons, new distribution pipeline and additional public fountains shall be constructed according to the current town situation.

(2) Kelewan Town

Water supply service has been stably managed as compared to other project sites. According to Water Desk in this town, any mechanical and structural problems have not arisen in the system. The layout of the existing water supply facilities is as shown in Fig. 1.2.2.

Water is supplied through 103 yard connections and 4 public fountains. 3 out of 4 public fountains are in function at present.

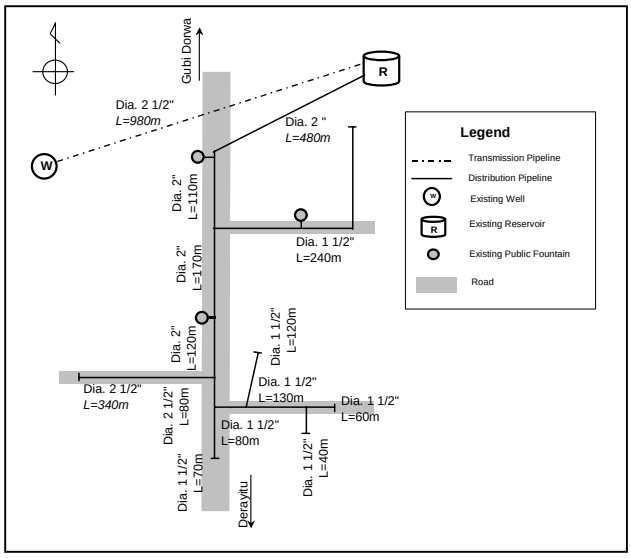


Fig.1.2.2 Layout of Existing Facilities of Kelewan

The current status and the problem of the existing facilities are summarized as follows.

Intake facility (deepwell) including pump and transmission pipeline	There is no big difference in the static water level and the Pumpage of the existing well in its construction stage (4.0 L/sec., GL-21.7m) and the Basic Design Study stage (4.2L/sec., GL-24m). For this reason, it is judged that this well can be utilized as it is. Beside of coving the whole Kelewan town, the existing well provides the water to 8 villages in same Woreda by water tanker, and the water tanker has fetched the water twice a day. There is a water tanker's pit in the system. The existing submersible motor pump is driven by a diesel engine generator. The existing generator was not fixed on the concrete base by volts. Therefore it is necessary to fix in order to avoid exhausting by the vibration of the generator itself.
Distribution Facilities	The existing reservoir is a typical RC structural model (cylinder type) with the capacity of $50m^3$ constructed in 2004 by AMHARA WWCE with the finance of the NGO of USA. It can be utilized as it is, because any leakage from the structure was not seen. Since the existing distribution pipeline was designed for an old system, it diameter arrangement is out of design hydraulically in the present system. Thus, it is necessary to replace the pipeline in accordance with a hydraulic calculation. In addition, it is necessary to construct public fountain additionally in order to meet the current situation of the town.

(3) Derayitu Town

The water supply system has not been in operation during last 8 months from last September due to the malfunction of previous mono-pump. Well pump was replaced from mono-pump by a new submersible motor pump in this April. The water supply situation was bit improved, but production water volume was not sufficient yet. The layout of the existing water supply facilities is as shown

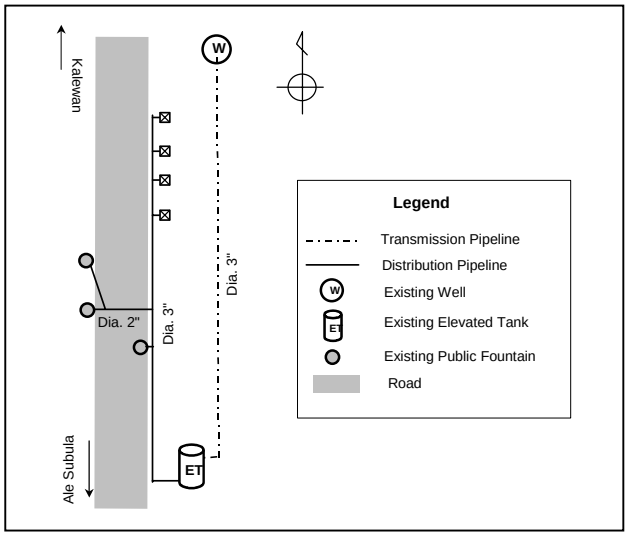


Fig.1.2.3 Layout of Existing Facilities of Derayitu

in Fig. 1.2.3.

There are 3 public fountains in the town, but those are constructed very closely. The current status and the problem of the existing facilities are summarized as follows.

Intake facility (deepwell) including pump and transmission pipeline	The appraisal of the well could not be made, because any data related to the existing well was unavailable. Well pump was replaced from old mono-pump to the submersible motor pump in April. However, new pump is not installed at right position, because there has been a part of the previous pump fallen in the well. For this reason, only a small quantity of the water is withdrawn. As fishing the fallen part of the pump is very difficult, it is recommended to construct a well additionally. And the exiting well can be utilized for emergency case such as droughty season, etc.
Distribution Facilities	The existing elevated tank has a storage capacity of 40m^3, and it can be utilized as it is. Though this capacity is equivalent to about 12 hours of maximum day demand for the present population, it is necessary to construct an additional elevated tank by considering increase of the future water demand. It is necessary to extent the distribution pipeline to meet the current situation of the town and to construct additional public fountains as well.

(4) Chifra Town

The layout of the existing water supply facilities is as shown in Fig. 1.2.4.

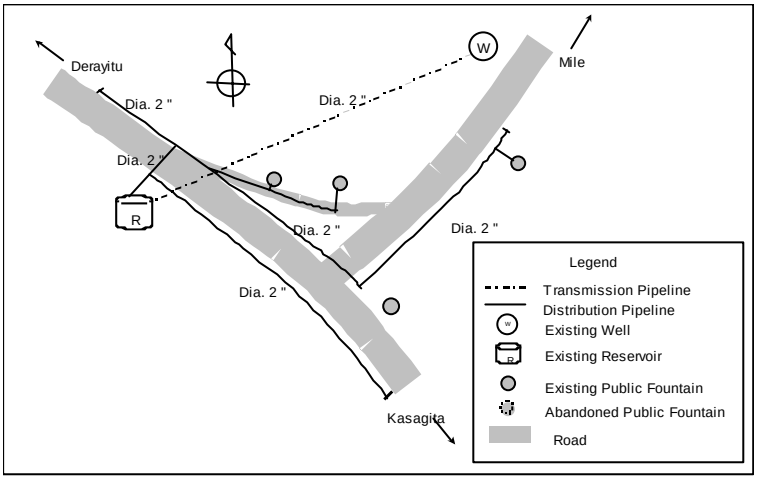


Fig. 1.2.4 Layout of Existing Facilities of Chifra

Water is currently served through 65 of yard connections and 4 of public fountains. Only 2 of the 4 public fountains are functional. Inhabitants gather to the public fountains and wait water running in long queue every day. During the public fountains in operation the water pressure usually decreases and residents with yard connection become difficult to receive water in its surrounding area.

The current status and the problem of the existing facilities are summarized as follows.

Intake facility (deepwell) including pump and transmission pipeline	The current pumpage was measured at 3.1L/sec., but the groundwater was transmitted irregularly. It was assumed the reason of such irregular transmitting might be mechanical trouble of well pump or clogging the transmission pipeline by air or sand due to non-installation of air valve and drain valve. Therefore, it is recommended to install valves for air release and blow-off in the transmission pipeline. According to the operator, the electric contact in the existing generator was not in good condition, but it could not be identified through the visual observation. Considering these situations, it is recommended to replace the existing pump set including control panel by new ones. It is necessary to fix the generator with the concrete base by volts in order to avoid exhausting by the vibration of the generator itself.
Distribution Facilities	As any leakage and crack in the existing reservoir were not seen, it is judged that the existing reservoir can be utilized as it is. The current storage capacity of the reservoir is estimated at about 7 hours of maximum day demand for the present population, thus, it is necessary to construct an additional reservoir to meet considering increase of the future water demand. It is necessary to extent the distribution pipeline and to replace the small diameter pipe to large diameter one. And the public fountain shall be constructed additionally as well.

(5) Eli Wuha Town

The inhabitants in this town has been faced with water shortage, but not so severe. There has been not any problem in the exciting water supply system, except transmission pipeline. The layout of the existing water supply facilities is as shown in Fig. 1.2.5.

Water is supplied through 77 yard connections and 4 public fountains. One out of 4 public fountains are in malfunction at present. There is a water point in the transmission pipeline for pastoralists to water their livestock. They dig ground and make a pond with about 3 m in both length and width and ladle muddy water from the pond. There is no other water point near here. According to Water Committee, the inhabitants in the town is sometimes pressed to fetch the water from other sources in dry season because a lot of pastoralists gather and water their livestocks at this water point.

The current status and the problem of the existing facilities are summarized as follows.

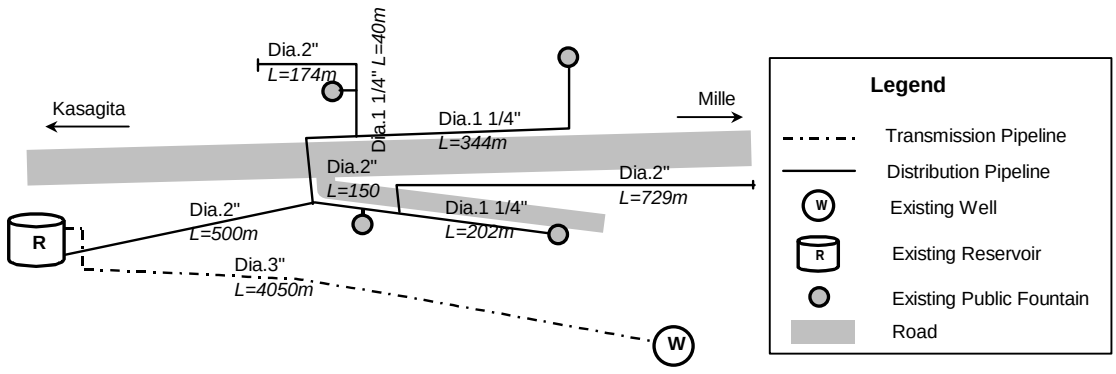


Fig.1.2.5 Layout of Existing Facilities of Eli Wuha

Intake facility (deepwell) including pump and transmission pipeline	The appraisal of the well could not be made, because any data related to the existing well was unavailable. According to the Water Committee, any problem in the existing submersible pump has not arisen so far. As the control panel for the pump has been set on the ground and used, it is necessary to fix the control panel on the wall for keeping in good working condition. The existing generator has been operated with the backup battery at present, due to a problem in the starter. As any problem was not identified besides the starter, it is recommended to utilize the existing generator as it is.
Distribution Facilities	The existing reservoir was constructed in 2004 by AMHARA WWCE at the own budget of the Afar regional government. According to the visual observation, no leakage in the existing reservoir was seen. Concerning the water point for pastoralists, it is necessary to construct a water trough for the livestock near the same place of the existing one to prevent uncontrolled water discharge and using unsafe water. It is necessary to replace the pipeline to meet the future water demand, and construct additional public fountains to meet the current situation of the town.

(6) Nemelefen Town

There has been not any problem in the existing water supply system, but water consumption is rather

low than the actual demand due to saline taste of water. The groundwater of the existing deepwell contains saline. For this reason, the inhabitants prefer to fetch drinking water from swallow well or natural springs exist along the Wata River.

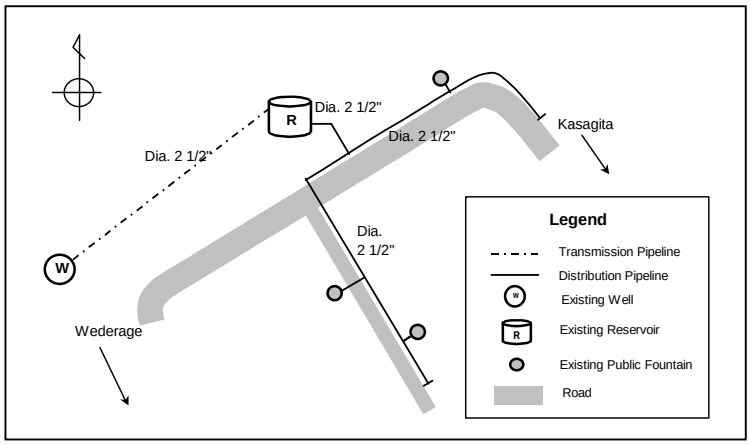


Fig.1.2.6 Layout of Existing Facilities of Nemelefen

The layout of the existing water supply facilities is as shown in Fig. 1.2.6. Water is supplied through 16 yard connections and 3 public fountains. One of 3 public fountains is in malfunction at present.

The current status and the problem of the existing facilities are summarized as follows.

Intake facility (deepwell) including pump and transmission pipeline	The appraisal of the well could not be made, because any data related to the existing well was unavailable. According to the operator, there has been not any problem in water supply system, and generator was replaced from old one to new one by ARWB. Water quality analysis on water of the existing well showed Sodium and Chloride contents exceed the permissive rate in Ethiopian guideline. These parameters are not harmful but matter of taste. It is preferable to target at the unconfined aquifer because shallow well water shows low contents of these minerals. A Small leak around the coupling of the check valve in transmission pipeline was seen. It can be repaired easily.
Distribution Facilities	As any leakage was not seen in the existing reservoir, the existing reservoir can be utilized as it is. However, it is necessary to construct an additional reservoir, because the storage capacity of the existing reservoir meets only present water demand. It is necessary to extent the pipeline to meet the current situation of the town, and to construct additional public fountains as well.

(7) Wederage Town

There was a water shortage in last year due to the breakdown of the generator, and the generator was replaced by a new one in January 2006.

The layout of the existing water supply facilities is as shown in Fig. 1.2.7. Water is supplied 10 yard connections and 2 public fountains. The public fountain users usually buy the water from the yard connection users because of the lack of public fountains.

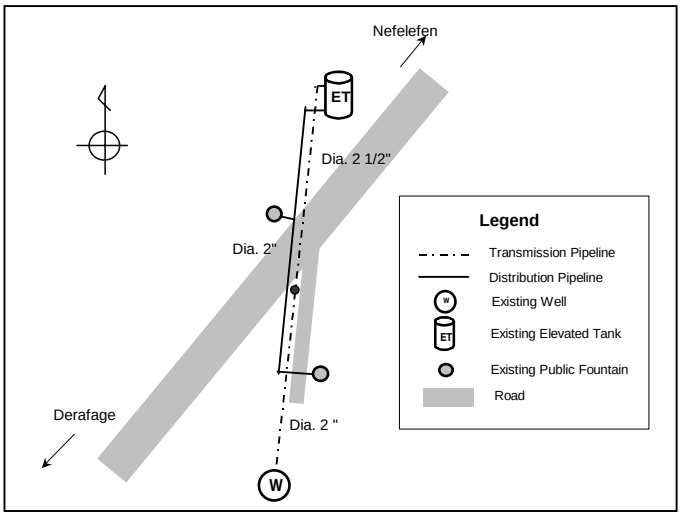


Fig.1.2.7 Layout of Existing Facilities of Wederage

The current status and the problem of the existing facilities are summarized as follows.

Intake facility (deepwell) including pump and transmission pipeline	Any data related to water level and yield of the existing well was unavailable. According to Woreda staff, water cannot be transmitted to the reservoir adequately at present. The reason of this phenomenon was assumed by an exclusive draw down of the groundwater level or deterioration of the pump capacity. Therefore it is recommended to clear the cause by the means of well rehabilitation The generator, which has been out of order for months was replaced by a new one in January 2006. Water quality analysis on the existing well shows higher contents of Sodium and Chloride than WHO's guideline, but less than Ethiopian guideline.
Distribution Facilities	The existing reservoir was constructed in 2003 by AMHARA WWCE at the own budget of the Afar Regional government. As any leakage was not seen in the existing, it can be utilized as it is. It is necessary to extent the pipeline to meet the current situation of the town and to construct additional public fountains as well.

(8) Kumami Town

As there is no water supply facilities in this town, the inhabitants have relied on water vendors who bring water from the city of Showa Robi 45km apart from Kumami town, or fetching water from the hand-dug well near the Robi River, a perennial river located about 10 km away from the town.

In Kumami two deep wells had been drilled in different schemes and the both had ended in failure or dry wells. Therefore it was jugged that groundwater potential is quite low in this area and test well drilling was not planned. At the early stage of the study a possibility of direct use of the surface water of the Robi River was considered. However, it was paid attention to use water to be contaminated by discharge of city waste water from Showa Robi city and chemicals of fertilizer or insecticide from fruit farms located at upstream of the Robi River. Accordingly it was verified that the direct use of the surface water was very risky and a water treatment plant should be needed for purifying the river water. Moreover, handling of the treatment plant was also supposed too difficult from the aspect of the capability of O&M. For these reasons, the surface water use was finally abandoned. As a result of the field survey and the geoelectrical soundings, groundwater, but not so deep, near the Robi River was decided as the most possible water source. For this purpose, an approach road must be constructed with about 3km length for the drilling point.

(9) Dulecha Town

As a new elevated tank was constructed in last year, water supply in the center of the town was improved. However, the inhabitants in the pericenter of the town have been facing with inconveniences to access water.

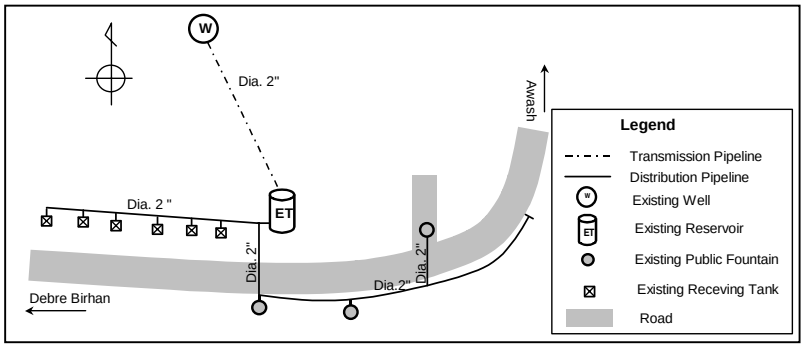


Fig.1.2.8 Layout of Existing Facilities of Dulecha

Concerning existing water supply system, any problem of the facilities was not reported at present. The layout of the existing facilities is as shown in Fig. 1.2.8. Water is supplied through only 3 public fountains. The current status and the problem of the existing facilities are summarized as follows.

Intake facility (deepwell) including pump and transmission pipeline	The appraisal of the well could not be made, because any data related to the existing well was unavailable. According to the water users group, any problem in the existing well including the pump and the generator arose in the past. Thus, existing facilities are recommended to utilize as it is.
Distribution Facilities	The existing elevated tank was constructed in 2005, and no water leakage was seen. Thus, existing tank is recommended to use as it is. The storage capacity almost meets with future demands, but water can be distributed within the central area due to low elevation of the tank. Water supply to the west side of the town is little difficult because the ground elevation rises gradually. However, new pipeline and additional public fountains will be extended to the west as far as the water can be distributed from the existing elevated tank and

1-2-4 Conditions of Hydrogeology and Potential of Groundwater Development

(1) Hydrogeology and Groundwater Potential

Geology of study area is summarized in Fig. 1.2.9, and the Study Area can be divided into the following two geological features from the hydrogeological point of view.

1) The area where the weathering basement covered by the vicinity of the surface:

The groundwater development potential is controlled by the geological formation of basement rocks. In general, Tertiary basalt (Ashangi formation basalt) is extremely weathered and its voids are filled with clay. Thus groundwater potential is very low. (yield is around 2L/sec) On the other hand, Quaternary basalt which has large fracture zone can be classified as high groundwater potential aquifer. (3L/sec or more of yield can be expected).

2) The area where the alluvium formed with the river deposit on the basement rock of the rift valley:

When the alluvial layer is thick, groundwater can be developed from the alluvial aquifer in addition to fractured zone of basement rock. However, there is danger such as collapses of wells during drilling of alluvial layer. Mud drilling must be applied in this area because of the collapse of well although drilling by air hammer is usually used in Ethiopia for the judgment of the amount of well yield. It would be difficult to evaluate the aquifer potential when mud drilling is used. Thus, geophysical well logging must be used to determine the screen position.

It is thought that a large amount of groundwater flows into the study area from the surroundings of the rift valley. Then groundwater recharge in study area seems to be high. Groundwater flow system is complex due to the structure of volcanic rock in the study area.

【Legend】

Sign	Age	Thickness (m)	Description
Ql	Quaternary	-	Lacustrine and swamp deposits, volcanolacustrine deposits of the rift valley
Qc	Quaternary	0-50	Eluvial and colluvial deposits, falus sheet floods and beach deposits
Qa	Quaternary	5-150	Alluvial deposits, sometimes terraced
Qt	Quaternary	-	Basaltic flows
Ma	Miocene	-	Amba Alaji rhyolites: ryholitic ignimbrites with acidic tuffs and some basalts
Qt λ	Miocene-Pleistocene	-	Dominantly silicic massifs, lava flows and domes, igmmbrites mostly ryholitic
Qt β	Miocene-Pleistocene	-	Fissural, dominantly basaltic lavas
Tv	Miocene-Pleistocene	-	Welega basalts with intercalations of acidic tuffs and loose clastics
T β	Pleistocene	-	Ashangi basals: poor y defined and deeply weathered basalt flows
hm	Precambrian	-	High-grade metamorphics : granitic and feldspathic gneiss, biotile and amphibole gneiss, rare granulites

Fig.1.2.9 Geological formation of afar region (Ethiopian Institute of Geological Survey, 1988)

⑵ Groundwater Chemistry

The Ethiopian Guideline on drinking water quality stands on the basis of the WHO Guideline. Chemical analysis of groundwater sample of the existing and the test wells in the study area was carried. The analysis was done at lab and on-site. In comparison with a WHO's guideline, the Ethiopian drinking water standard, however, some indicators of the Ethiopian Guideline are adopted looser values than WHO's ones, because ground water of Ethiopia is often influenced from volcanic activity, and it is difficult to substitute by another souse of drinking water. According with these things, Ethiopian standard is adopted as a water quality standard value in this project. About the item which is not in a Ethiopian standard, it judges suitably. Table 1.2.4-1and 2 show the result.

1) Groundwater chemistry of existing wells

Water samples taken from Gubi Dowra, Nemelefen, and Wederage, have high EC and salinity values. It seems that the ion source is volcanic origin as high temperature of groundwater indicated. A long-term monitoring on water quality is necessary for wells detected more than 1mS/cm (1,000μS/cm) although there is no drinking water standard value for both EC and salinity in Ethiopia and WHO.

In addition to EC and salinity, Eli Wuha has high Na, SO_4 and NO_3 concentrations. In Gubi Dorwa Na and NO_3 concentrations exceed the drinking water standard. Gubi Dorwa has also high Cl and SO_4 values. In Nemerefen, Na, F and Cl concentrations exceed the drinking water standard of WHO. SO_4 concentration is also rather high. Water sample taken from the hand pump indicated high NO_3 value, which is over drinking water standard. Sample taken from Wederage well has high Na, Cl and NO_3 concentrations. It is noted that water samples taken from the deepwell of Eli Wuha, Gubi Dorwa and Wederage contained high NO_3 concentration. In general, deep groundwaters do not contain high NO_3. It seems that contaminated water flows into the well due to the poor well construction. This is one possible explanation of this high NO_3 value.

2) Groundwater chemistry of test wells

In Gubi Dowra, pH, Na and F values exceeded those of the drinking water standard. The values of Alkalinity and HCO_3 are higher than those of the existing well of Gubi Dowra. It seems that groundwater sample taken from the test well comes under the influence of volcanic formation than that taken from existing well. Thus it was not suitable for drinking. On the other hand, in Nemerefen and Wederage, water samples taken from test wells have lower values of TDS, EC, Na, Cl, F and SO_4 than existing wells. This means that water from test well has better quality than existing wells. This discrepancy may indicate that groundwater source of each well differs.

1-2-5 Test Wells and Yield of Groundwater

(1) Groundwater Verification Study

In order to estimate groundwater potential for 8 target towns, groundwater verification study was conducted in this Basic Design Study. The verification study consisted of 1) data collection and analysis, 2) geophysical prospecting, and 3) test well drilling. Based on the result of those studies, groundwater potential was estimated for 8 towns.

Data such as hydrogoelogical maps, aerophotos related to the Project sites were collected and analyzed. In advance, geophysical prospecting was executed at the existing wells to grasp geological features of an existing well, since the well data such as log data, casing program, etc. was not kept properly.

Vertical electrical sounding (VES) and two-dimensional resistivity survey (2D) were executed. Total of 56 VES was carried out to select the drilling sites. Two more VES were carried out in Kumami to decide the depth of shallow well. Moreover, 2D survey was executed to understand the geologic structure in the Eli Wuha, Chifra, and Nemelefen where the geology is complex. Table 1.2.3 shows the number of VES points and 2D profile in each town.

The results of the geophysical prospecting for the test wells were compared to the one of the existing wells. Finally, the test well drilling sites where the groundwater potential is higher than an existing well were selected. Although test wells drilling was originally planned to execute at 8 towns, finally it was done at 7 towns because one town was excluded due to a bad accessibility by a heavy rain.

(2) Geophysical Characteristic of Aquifer in the Study Site

Geological features and the aquifer structure were estimated from the measured resistivity values of each site. The result was used to define the aquifer resistivity and aquifer depth (Table 1.2.3).

It can be seen from the table that aquifer resistivity obtained from the analysis of resistivity curve ranges from 16 Ohm-m to 50 Ohm-m. An aquifer depth is 60m to 150m.

Table 1.2.3 Number of Resistivity and Result of Survey in Each Town

Town	VES	2D profile	Aquifer Resistivity (Ohm-m)	Aquifer Depth (m)
Gubi Dorwa	8		28	120-150
Kelwan	4		19	80-90
Derayitu	4		19	100-120
Chifra	7	1	20	100－120
Eli Wuha	8	1	50	120－130
Nemelefen	7	1	26	60
Wederage	10		20	120-140
Kumami	2			
Dulecha	8		16	80-130
Total	58	3		

(3) Test Wells

Test wells were drilled with the diameter of 10inch by the methods of air hummer or mud rotary drilling according to geological conditions. Well logging was conducted as soon as the drilling work is completed, and the casing program was made on the basis of the well logging. And then, PVC casing and screen pipes with the diameter of 6 inch were installed according to the casing program. Concerning Gubi Dowra town, casing and screen pipes have been not installed due to the volcanic rock, which has no fear for collapse of wall of borehole. The result of Test Well Drilling is summarized in Table 1.2.4.

(4) Optimal well yield and aquifer parameters

Maximum well yield was estimated, using the result of step drawdown test. Aquifer parameters such as transmissivity and hydraulic conductivity were calculated by the results of drawdown and recovery tests (Table 1.2.4).

It can be seen that the values of hydraulic conductivity and transmissivity varied in each site. They differ by three orders of magnitude. This means hydrogeological difference between the sites. The values of each site also show the difference of groundwater potential. The value of Chifra shows the highest potential, and the lowest one was shown in Wederage and Nemelefen.

The pumapge is comparatively high in Chifra, Deraytu, and the Dulecha town (>5.0 L/sec). On the other hand, the rate of Nemelefen and Wederage towns are relatively low. The optimal yield is set as shown Table 1.2.6

Table 1.2.4 Result of Water Quality Analysis

●Water analysis by Laboratory

No.		Guideline				Gubi Dowra (Ex.)	*Gubi Dowra (Test)*	Kelewan (Ex.)	Derayitu (Ex.)	*Derayitu (Test)*	Chifra (Ex.)	*Chifra (Test)*	Eli Wuha (Ex.)	*Eli Wuha (Test)*
		WHO	Japan	Ethiopia										
		Target	Standard	for Health	Complaints for consumers									
1	Turbidity(NTU)	5	2	7	-	4	*1*	2	-	*trace*	2	*1*	1	
2	Total Dissolved Solid (mg/l)	1,000	500	-	1,776	1,216	*1,632*	375	-	*532.0*	646	*600*	800	658
3	E-conductivity (µS/cm)	-	-	-	-	2,100	*2,480*	549	-	*812*	982	*590*	1,142	
4	pH	-	5.8-8.6	-	6.5-8.5	8.20	*8.65*	7.55	-	*8.38*	7.3	*8.22*	7.9	7.6
5	Ammonia (mg/l NH_3)	-	-	-	2	0.15	*0.13*	0.19	-	*0.38*	0.15	*0.25*	0.13	0.22
6	Sodium (mg/l Na)	200	200	-	358	320	*465*	34	-	*50*	78	*86*	200	186
7	Potassium (mg/l K)	-	-	-	-	26.50	*29.0*	1.60	-	*7.0*	6.50	*8.2*	3.60	3.5
8	Total Hardness (mg/l $CaCo_3$)	300	300	-	392	130.20	*125.4*	243.04	-	*358.6*	351.54	*338.8*	141.05	127.6
9	Calcium (mg/l Ca)	-	-	-	-	29.58	*33.4*	63.51	-	*78.3*	93.96	*107.4*	56.55	29.4
10	Magnesium (mg/l Mg)	-	-	-	-	13.78	*10.3*	20.97	-	*39.96*	28.62	*17.3*	15.90	13.5
11	Total Iron (mg/l Fe)	0.3	0.3	-	0.4	0.03	*0.02*	0.03	-	*0.02*	0.02	*trace*	Trace	trace
12	Manganese (mg/l Mn)	0.1	0.05	-	0.13	0.02	*0.02*	Trace	-	*0.02*	Trace	*trace*	Trace	0.02
13	Fluoride (mg/l F)	1.5	0.8	-	3.0	1.10	*5.75*	0.15	-	*0.04*	0.50	*0.8*	0.15	0.345
14	Chloride (mg/l Cl)	250	200	-	533	154.60	*105.6*	18.24	-	*50.76*	60.48	*57.6*	53.76	72.96
15	Nitrate (mg/l NO_3)	50	10	50	-	57.50	*0.7*	8.50	-	*0.86*	8.00	*1.78*	40.00	16.35
16	Alkalinity (mg/l)	-	-	-	-	291.70	*614.3*	226.44	-	*257.04*	320.30	*359.1*	367.20	291.1
17	Carbonate (mg/l CO_3)	-	-	-	-	7	*36*	Trace	-	*9.6*	Trace	*4.8*	Trace	Trace
18	Biocarbonate (mg/l HCO_3)	-	-	-	-	341.26	*676.2*	276.26	-	*294.1*	390.74	*428.3*	448.00	355.1
19	Sulphate (mg/l SO_4)	-	-	-	483	285.50	*330.0*	41.25	-	*121.0*	144.00	*42.4*	167.75	143

(Water Works Desing & Supervision Enterprise Water Laboratory)

●Water analysis by portable meter at site

20	E-conductivity (µS/cm)	-	-	-	-	2,600		630	-		1,000		1,080	
21	pH	-	5.8-8.6	-	6.5-8.5	8.3		8.0	-		7.5		7.8	
22	Arsenic (mg/L As)*	0.01	0.01	-	-	ND		ND	-		ND		ND	
23	Salinity concentration (%)	-	-	-	-	0.13		-	-		-		-	
24	E-coli or thermo tolerant Coliform bacteria	-	100/1ml	0/100ml	-	-		<50	-		0		0	
25	Total Coliform Bacteria	-	0	0/100ml	-	-		<10	-		0		0	

* by pack test. (limit of detection >0.2mg/L)

Table 1.2.4 Result of Water Quality Analysis

●Water analysis by Laboratory

No.		Guideline				Nemelefen (Ex.)		*Nemelefen (Test)*	Wederage (Ex.)	*Wederage (Test)*	Kumami (Robi river)	Dulecha (Ex.)	*Dulecha (Test)*
		WHO	Japan	Ethiopia		Deep Well	Hand Pump						
		Target	Standard	for Health	Complaints for consumers								
1	Turbidity(NTU)	5	2	7	-	2	2	*1*	1	*Trace*	71	2	*1*
2	Total Dissolved Solid (mg/l)	1,000	500	-	1,776	1,558	693	*586*	880	*688*	360	361	*206*
3	E-conductivity (μS/cm)	-	-	-	-	2,500	1,085	*951*	1,492	*1,163*	542	503	*359*
4	pH	-	5.8-8.6	-	6.5-8.5	8.1	7.9	*7.67*	7.4	*8.26*	8.4	7.5	*7.64*
5	Ammonia (mg/l NH_3)	-	-	-	2	0.11	0.13	*0.50*	0.10	*0.15*	0.19	0.15	*0.125*
6	Sodium (mg/l Na)	200	200	-	358	520	162	*99*	214	*140*	53	36	*20.5*
7	Potassium (mg/l K)	-	-	-	-	1.90	0.60	*2.7*	4.30	*4.2*	6.30	2.40	*2.8*
8	Total Hardness (mg/l $CaCo_3$)	300	300	-	392	121.52	130.20	*297.0*	193.10	*248.6*	151.90	217.00	*149.6*
9	Calcium (mg/l Ca)	-	-	-	-	27.03	46.10	*94.2*	68.73	*82.7*	43.50	63.50	*48.4*
10	Magnesium (mg/l Mg)	-	-	-	-	2.65	3.71	*15.1*	5.30	*10.3*	10.60	14.30	*7.02*
11	Total Iron (mg/l Fe)	0.3	0.3	-	0.4	0.04	0.04	*0.03*	Trace	*0.02*	Trace	Trace	*Trace*
12	Manganese (mg/l Mn)	0.1	0.05	-	0.13	Trace	Trace	*0.07*	0.05	*0.02*	0.07	0.05	*0.02*
13	Fluoride (mg/l F)	1.5	0.8	-	3.0	1.84	0.45	*0.61*	0.15	*0.81*	0.45	0.50	*0.61*
14	Chloride (mg/l Cl)	250	200	-	533	576.00	121.00	*87.4*	315.80	*158.4*	27.80	7.70	*9.6*
15	Nitrate (mg/l NO_3)	50	10	50	-	7.00	57.50	*5.30*	30.00	*16.53*	7.50	8.50	*3.65*
16	Alkalinity (mg/l)	-	-	-	-	28.60	67.30	*311.9*	59.20	*215.5*	163.20	250.90	*164.4*
17	Carbonate (mg/l CO_3)	-	-	-	-	Trace	Trace	Trace	Trace	*4.80*	7	Trace	*Trace*
18	Biocarbonate (mg/l HCO_3)	-	-	-	-	34.84	82.10	*380.5*	72.20	*253.1*	184.50	306.10	*200.6*
19	Sulphate (mg/l SO_4)	-	-	-	483	390.50	182.90	*33.0*	93.50	*48.4*	37.90	50.50	*12.1*

(Water Works Desing & Supervision Enterprise Water Laboratory)

●Water analysis by portable meter at site

20	E-conductivity (μS/cm)	-	-	-	-	3,000	1,300		2		640	600	
21	pH	-	5.8-8.6	-	6.5-8.5	8.4	8.0		7.9		7.8	7.0	
22	Arsenic (mg/L As)*	0.01	0.01	-	-	ND	ND		ND		ND	ND	
23	Salinity concentration (%)	-	-	-	-	0.16	0.07		0.09		0.03	0.03	
24	E-coli or thermo tolerant Coliform bacteria	-	100/1ml	0/100ml	-	>1000	0		0		>1000	<1000	
25	Total Coliform Bacteria	-	0	0/100ml	-	<10	0		0		>50	>50	

* by pack test. (limit of detection >0.2mg/L)

Table 1.2.5 Summary of Test Well

Town Name	Start	End	Drilling Method	Drilling Depth	Casing Depth	Casing Material	Screen Material / Open Rate	Screen Position	Total Screen Length	Screen L / Casing L	Static Water Level	Dynamic Water Level by Constant Test	Maximum Well Yield (Constant test rate)	Transmissivity	Hydraulic conductivity	*Optimal Yield*	Plan for Pump Position
				m	m			m	m	%	m	m	L/sec	m2/day	cm/sec	L/sec	m
Gubi Dowra	22-Jan-06	5-Feb-06	Air with T.Bit Air with H.Bit	149	-	No casing	No casing	No Screen	-	-	33.25	106.82	2.0	1.2	-	1.0	138
Kelewan	22-Jan-06	20-Feb-06	Air with T.Bit Air with H.Bit	30	-	-	-	-	-	-	-	-	-	-	-	-	-
Deraiytu	4-Mar-06	9-Apr-06	Air with T.Bit Mud with T.Bit	62	57.7	PVC	PVC / 8%	32.23 - 40.72 43.55 - 52.04	17.0	29.5%	27.5	30.46	5.0	898	6.94E-01	3.0	52
Chifra	10-Feb-06	26-Feb-06	Air with T.Bit Air with H.Bit	122	99	PVC	PVC / 8%	76.36 - 84.85 87.68 - 93.34	14.2	14.3%	40.1	44.9	> 6.3	1881	1.54E+00	6.7	66
Eli Wuha 1	7-Mar-06	25-Mar-06	Air with T.Bit Air with H.Bit	130	-	No casing	No casing	-	-	-	40	-	-	-	-	-	-
Eli Wuha 2	19-Apr-06	9-May-06	Air with T.Bit Mud with T.Bit	131	131	PVC	PVC / 8%	62.7 - 74 108.46 - 125	27.8	21.2%	33.0	42.3	4.5	35.57	1.57E-02	4.5	55
Nemelefen 1	27-Feb-06	10-Mar-06	Air with T.Bit Air with H.Bit	45	-	No casing	No casing	-	-	-	-	-	-	-	-	-	-
Nemelefen 2	10-Mar-06	5-Apr-06	Air with T.Bit Mud with T.Bit	61	60	PVC	PVC / 8%	33.06 - 41.55 47.28 - 55.70	16.9	28.2%	8.0	38.7	2.0	1.55	1.04E-03	1.5	42
Wederage	20-Feb-06	27-Feb-06	Air with T.Bit Air with H.Bit	110	110	PVC	PVC / 8%	73.21 - 76.04 78.80 - 90.19 95.85 - 104.30	22.7	20.6%	30.5	70.8	2.5	2.5	1.27E-03	2.0	71
Dulecha	22-Feb-06	5-Mar-06	Air with T.Bit Air with H.Bit	78	73	PVC	PVC / 8%	34.0 - 46.0 52.0 - 70.0	30	41.1%	25.9	29.2	> 6.7	153	5.90E-02	4.5	30
TOTAL				*918*	*530.7*				*128.6*	24.2%							

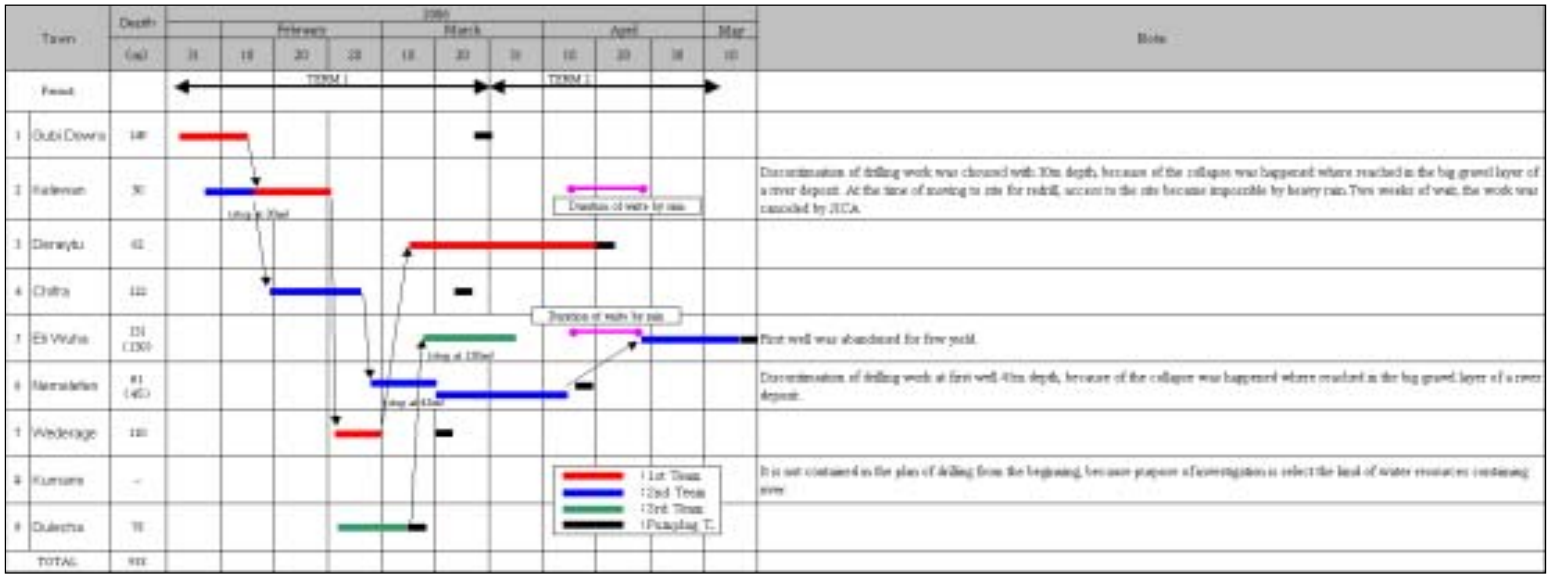


Table 1.2.6 Yield Value of Existing Well and Optimal Yield of Test Well

Town	Pumping rate of existing wall (L／Sec)	Value of continuous yield (L／Sec)	**Optimal yield (L／Sec)**	Notes
Gubi Dorwa	3.5	1.5	**1.0**	Set the optimal yield by recovery test, for recovery is too rate.
Kelwan	4.1	-	**4.7**	Set the optimal yield by water demand design.
Derayitu	3.5 (by report)	5.0	**3.0**	Set the optimal yield, as rate not downed screen position by dynamic level.
Chifra	4.4	6.3	**6.7**	Set the optimal yield by water demand design. (according to the result, possibility was admitted to pump more than result value.)
Eli Wuha	3.6	4.5	**4.5**	Set the optimal yield as continuous yield.
Nemelefen	1.5	2.0	**1.5**	Set the optimal yield, as rate not downed screen position by dynamic level.
Wederage	1.5	2.5	**2.0**	Set the optimal yield, as rate not downed screen position by dynamic level.
Kumami	-	-	**3.0**	Set the optimal yield by water demand design.
Dulecha	1.8	6.7	**6.7**	Set the optimal yield by water demand design.

(5) Area influenced by Test Well

The range of the influence by groundwater abstraction was calculated by using the hydraulic conductivity and the storage coefficient (Table 1.2.7). This is an amount of the groundwater level decrease only by the drilled test well. This does not take into account of influence of the existing well and seasonal groundwater level fluctuations.

The table shows that declining of groundwater level is remarkable in Gubi Dorwa and Wederage. Groundwater level in these areas may be dropped by around 2m at the 100m distance from well. On the other hand, groundwater level does not change by pumping at the distance from well in Chifra, Derayitu, and Dulecha. The amount of groundwater level declining is estimated to be 50cm or less in any well at the 300m distance from well.

Table 1.2.7 Estimation of Lowering of Groundwater Level around Well by Abstraction

Test well	Distance from well (m)								
	2	10	20	30	50	100	150	200	300
Gubi Dorwa	17.29	10.96	8.28	6.68	4.76	2.32	1.17	0.58	0.11
Kelwan	-	-	-	-	-	-	-	-	-
Derayitu	0.82	0.65	0.58	0.53	0.48	0.41	0.37	0.33	0.29
Chifra	1.35	1.09	0.97	0.90	0.81	0.70	0.63	0.58	0.52
Eli Wuha	1.35	1.79	1.52	1.35	1.15	0.88	0.72	0.61	0.45
Nemelefen	7.11	4.60	3.50	2.85	2.09	1.11	0.59	0.32	0.08
Wederage	9.56	6.34	4.95	4.15	3.14	1.82	1.11	0.70	0.26
Dulecha	1.30	1.0	0.86	0.78	0.69	0.56	0.48	0.42	0.35

CHAPTER 2. CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Superordinate Plan

WSDP is the superordinate to any plans in water supply sector in Ethiopia and indicates comprehensively the goal and the strategies for the improvement of water supply systems in the country for supporting poverty reduction and sustainable development.

WSDP aims to improve the water supply coverage at 44%(urban) 14%(rural), 90%(urban) 62%(rural), 74%(urban) 46%(rural) by the year of 2001, 2011, 2016 respectively, as shown by Table 2.1.1. It proposes the construction plans of the water supply facility to achieve the goal, and anticipates investment amounts US Dollar 29.3million from 2002 to 2006, US Dollar 29.9million from 2007 to 2011, and US dollar 37.8million from 2012 to 2016), US Dollar 96.9million in total.

Table 2.1.1 Current and Aimed Water Supply Coverage in the Afar region

2001		2006		2011		2016	
Urban area	Rural area	Urban area	Rural area	Urban area	Rural area	Urban area	Rural area
44%	14%	59%	30%	74%	46%	90%	62%

Source: *Water Sector Development Program, Ministry of Water Resources*

In order to achieve the goals in WSDP, the Government of Ethiopia has elaborated “National Water Supply and Sanitation Master Plan (2002)”, “Urban Water Supply and Sanitation Program Regional Implementation Guideline (2004)” and “Rural Water Supply and Sanitation Program Regional Implementation Guideline (2004)” which have suggested state-wise tactics.

2-1-2 Objective of the Project

The objective of the Project is to increase the served population that can access safe potable water stably in the Afar State.

2-1-3 Outline of the Project

In order to achieve the above objective, the Project has been formulated in this Study. The Project is basically composed of three components: 1) the construction of water supply facilities for 9 towns, 2) the procurement of the equipment for the well rehabilitation, and 3) the capacity building of human resources (Soft Component). The Project Design Matrix (PDM) of the project is as shown by Table 2.1.4.

Water supply facilities in 9 towns will be improved or constructed, based on water demand at the target year. The construction of water supply facilities in 9 towns is summarized in Table 2.1.2.

Table 2.1.2 Contents of Facility Development

Item	Contents	Number	Remarks
Water source facility	Reuse of test wells as production wells	6wells	Wells was constructed in the Basic Design Study
	Construction of new deep wells	6wells	
	Rehabilitation of existing wells	3wells	Work will be implemented by soft component
	Well pump and electric generator	12sets	
	Electric generator room	12sets	
Water supply facility	Pipe line: φ50mm to φ75mm	21,280m	
Water distribution facility	Distribution reservoir; $50m^3$ to $130m^3$ Elevated water tank; $50m^3$, H=6m	6sets 1set	
	Pipe line φ50mm to φ100mm, (include incidental facilities)	19,740m	
	Public water tap Public drinking fountain for live stock	28sets 1set	

The equipment necessary for well rehabilitation work will be procured and is summarized in Table 2.1.3.

Table 2.1.3 Equipments and Materials for Procurement

Item	Specifications	Number	Detail
Well rehabilitation equipment with related accessories	Cargo truck with 3ton crane, PLD10ton	1set	For well development
	Cargo truck with 3ton crane, PLD6ton	1set	For pumping test
	Submersible pump (2units), Generator	1set	
	Equipment and tools for well development	1set	
Survey equipment	Water analysis kit	1set	

Capacity building of human resources (Soft Component) will be conducted and is composed of following two fields.

- Improvement of AWRB's staff in well rehabilitation skill.
- Improvement of Water Committees and Water & Sanitation Office of each Woreda (WSO) in managerial capability for water supply service.

Table 2.1.4 Project Design Matrix (PDM) of the Project

Narrative Summary	Verifiable Indicators	Means of Verification	Important Assumptions
【Overall Goal】 Sanitary condition in the Afar National Regional State is improved.	• Morbidity rate of water-born diseases decreases.	• Interview survey of Health Department in Woreda Council. • Health data in Health Bureau of regional government.	• Inflation or deflation does not arise. • Famine or drought does not occur continuously.
【Project Purpose】 Served population that can access safe potable water stably increase in the Afar State	• Water supply coverage rate increases. • Good quality water is always supplied. • Suspension period of water supply system deceases.	• Interview survey of Water Committees and WSO. • Record of water quality analysis • Interview survey of Water Committees	• AWRB, WSO and Water Committees continue their own tasks. • Drastic changes in the potential of groundwater do not occur.
【Outputs】 • Water supply facilities in the target area are improved. • Technical capability of AWRB in well rehabilitation is improved. • Technical capability of WSO and AWRB in O&M is developed. • Capability of Water Committee in management of Water Supply is improved.	• Inhabitants always fetch safe water easily. • Functional existing wells increase. • WSO assists Water Committees quickly. • Management of water supply service is made without any difficulties.	• Interview survey to inhabitants. • Completion report on Well Rehabilitation. • O&M record of WSO and AWRB. • Financial record of Water Committees and Interview survey	• Water supply facilities are always operated with good conditions. • Trained personnel do not quit. • Preventive maintenance is continued by WSO. • Cost recovery rate do not decrease.
【Activities】 [Japanese side] • Improvement of water supply facilities including groundwater development. • Procurement of the equipment. • Capacity building for O&M and management of water supply service. [Ethiopian side] • Ensuring of the land for the facilities • O&M of water supply facilities • Assistance of the Water Committees	【Input】 [Japanese side] • Construction of water supply facilities at 9 sites. • Procurement of equipment for well rehabilitation. • Technical transfer on well rehabilitation. • Technical transfer on O&M.	[Ethiopian side] • To secure land for construction. • Construction of access road. • Deploying proper human resources for technical transfer. • Deploying personnel in WSO.	• Basic concept against the Project does not change.

2-2 Basic Design of the Requested Japanese Assistant

2-2-1 Design Policy

2-2-1-1 Concept for Project Sites Selection

The Government of Afar National Regional State has proposed nine towns as the project sites in the original request to Japan. The JICA study team has conducted the field survey in order to grasp natural conditions, socio-economical conditions, water supply conditions, and hydrogeological conditions etc for those 9 towns. Based on the survey results, the study team has prioritized the sites for the improvement of water supply facilities. The selection of the project sites was based on a concept that the site without any reliable groundwater for water supply should be omitted from the Project.

A groundwater verification study was conducted in 9 proposed towns by means of aero photo analysis, field reconnaissance, geoelectrical survey, etc. Based on those results, test well drilling was conducted. As a result, the aquifer had been stricken in seven towns: Gubu Dowra, Derayitu, Nemelefen, Chifra, Wederage, Eli wha and Dulecha. Test well drilling in Kelewan Town was once tried, but canceled due to limited time schedule. Concerning Kumami Town, test well drilling was not planned originally. However, it is evaluated that there is the potential for groundwater development in these two towns according to the results of geoelectrical survey. Consequently, all the nine proposed sites have been selected as the Project sites.

2-2-1-2 Policy for Facility Design

(1) Policy for Natural Conditions

- The proposed towns are located in the west part of the low land of the Rift Valley and each site is scattered in a range of about 300km from north to south and at altitudes between 650m and 1050m above sea level. The target sites are situated in the area with very severe natural conditions. The climate of the area is classed as a tropical dry or semi-arid climate, the annual mean temperature is between 35-40℃, and the annual rainfall in the area is around 380mm. Severe drought sometimes breaks out in the area.

  The life span of mechanical equipment used in the low land is shorter than the one used in high land such as Amhara region, Tigray region, etc. Therefore, careful consideration shall be paid when the technical specification of the mechanical equipment is decided.

- There are volcanoes in the Rift Valley formed by geological activities of detachment of the African plate and the Indian Ocean plate. Groundwater in the Rift Valley is influenced by volcanic activity. For instance, some groundwater with a high temperature of around 40℃ are observed. Groundwaters in the towns of Gubi Dowra and Nemelefen have a high TDS (Total Dissolved Solids) content more than 1000 mg/liter. For these reasons, careful attention for such

characteristics shall be paid to decide the technical specifications for submersible pumps and riser pipes.

- The volcanic activities make the soil condition unique. As the soil conditions of the project sites are dominated mainly by the exposure of volcanic rocks and boulders, suitable excavation methods for pipe laying works shall be adopted in such rocky soil.

(2) Policy for Socio-economic Conditions

- Most proposed towns have been politically developed as the administration centers of the Woreda. Among all the proposed towns only Kelewan has a town development plan elaborated by the Government of the Afar Regional State. Generally there are one-story buildings, which are almost administrative offices, and private houses constructed along the main road in each proposed town. In these towns, the road network is not properly formed due to a poor lotting arrangement. Therefore the proposed distribution pipeline shall be planed generally to lay along the main road and the inside roads which can be identified clearly in each proposed town.

- Although an electricity distribution system with a diesel engine generator was installed in each proposed town, its stable operation has not been started yet except Eli Wuha town. Even in Eli Wuha town, service hour of electricity is six hours from 18:00 to 24:00 with 220 volts for only domestic use. As all the electric systems do not have enough capacity for the proposed well pump operation in voltage and in operational hour, a set of electric generator will be installed for each proposed well pump.

- In Eli Wuha town, there is a water point along the transmission main of the existing water supply system. Pastoralists dig a mud water trough there and take their livestock to water at the trough because no other water point exists in the surrounding area. This water point is very common among the pastoralists. There is an operational difficulty in transmitting groundwater to the reservoir due to water discharge there. Therefore, a new concrete trough with a valve shall be installed there for pastroralists so that transmitting water can be managed easily.

(3) Policy for Constructional Conditions

- It is quite difficult to employ capable private construction companies or skilled workers in regional towns. Therefore common construction methods shall be adopted instead of specific method, which needs special equipment or various skilled workers.

- In Afar Region, drilling method of mud circulation is widely required for drilling of alluvial soil. There are several drilling companies with experienced drillers in Addis Ababa. However, there are very few companies that have neither working experience in Afar Region nor drilling method of mud circulation. Therefore, it is essential to employ drilling company which can perform a reliable drilling work including the mud circulation method under the supervision of Japanese contractor.

- As there are not much skilled technicians in installations of machinery or electric facilities in Ethiopia, Japanese experts shall be dispatched to the project sites for installation and initial operational setting of the proposed facilities.

(4) Policy for Equipment Procurement

- Materials for the construction works are galvanized steel pipes, valves, reinforcement bars, concrete blocks, cement, gravels etc. As these materials are available in local market except valves, the construction materials shall be basically procured in local market.

- Mechanical equipment such as submersible pumps and electric generators are normally imported in Ethiopia. There are various suppliers dealing with machinery products of European manufacturers in Addis Ababa, and the spare parts of machinery products also can be procured through such suppliers. Therefore those equipments shall be basically procured imported ones from the third countries.

(5) Policy for Use of the Existing Facilities

- The existing water supply facilities including mechanical equipment such as submersible pumps, generators, etc. can be basically used, as long as those are in operational condition. Unless the capabilities of the mechanical equipments or pipes meet the technical requirements, such existing ones shall be replaced by new ones with sufficient capacities.

- In the target sites, none of air valve and drain valve was installed along the existing pipeline. It is assumed that necessary sectional area of pipe cannot be kept due to air block at convex points or sand sediment at concave points of the pipelines. Therefore, air valves and drain valves shall be installed in the necessary points of the existing pipelines.

- As there is fallen submersible pump in the existing well in Derayitu town, it is, reportedly, difficult to install the pump at specific position. As any well data including yield is unavailable, it is too risky to install new submersible pump into this existing well and utilize as production well. In addition, the existing well in Gubi Dowra town was also risky to use as it is because there is reliable well data for verification of its future use. Therefore these two wells will be abandoned, and new wells shall be drilled in each town instead.

2-2-1-3 Policy for Equipment Procurement

The equipment requested by AWRB is for well rehabilitation works. The selection of the equipment shall be based on the following policies.

- AWRB has planned to conduct well rehabilitation works by means of developing of jetting work, which is effective for removal of scum or scales stuck at screen slits. AWRB also has planned to conduct pumping test in order to obtain proper pumpage of the existing wells. Jetting work and pumping test are quite basic and technically applicable for the technicians in AWRB. Therefore the equipment necessary for well rehabilitation shall be procured to meet these plans.

- The varieties and quantities of the equipment including accessories & tools shall be procured to meet the numbers and technical level of the technicians in AWRB. In addition, it is necessary to consider, based on the items, number, performance and condition, etc. of the existing equipment and the relevant accessories & tools, which AWRB owns, such as a service rig and a mobile workshop.

- The equipment will be composed mainly of vehicles mounted with various machinery specialized to be used for rehabilitation work of well. Therefore the equipment shall be procured from Japan or the third countries if the specific products and their spare parts are not available in the local market.

2-2-1-4 Policy for Capacity Building on O& M

The responsible and relevant organizations to the Project are AWRB, Woreda Councils and Water Committees in the proposed towns. The following programs of capacity building are planned for them as soft components of the Project.

- A maintenance service rig and a mobile work shop were donated to AWRB through the Water Supply Development and Rehabilitation Project, which was implemented for enhancement of capacity of 25 towns water supply bodies in all over the country by a financial assistance from World Bank in 2002. Technical trainings on well rehabilitation was made to AWRB's technicians and operators by the Ministry of Water Resources (MoWR) at that time, but their skill level is still insufficient. In 2005 AWRB has planned a scheme on the rehabilitation of damaged or malfunctioning existing wells in Afar region. In addition, 6 wells have been drilled as test wells in this Basic Design Study, and 6 wells will be drilled additionally through the Project. As those wells, new production wells were drilled annually. Accordingly, enhancement of well rehabilitation technique will be quite essential for AWRB to support the sustainable O&M of water supply facilities.

- According to the concept of water supply management on small towns and communities in Ethiopia, water supply service is made by Water Committee, and special maintenance and replacement are carried out by the Water Desk in Woreda council or AWRB. However, there are malfunctioned Water Committees in some towns, nor Water Desk under financial and technical difficulties. Therefore a program of capacity building on water supply management shall be planned to conduct through the Project for establishing a water committee and enhancing their performances for O&M of the water supply facilities in each proposed town. The program shall be conducted on a community participatory basis in cooperation with AWRB and Water and Sanitation Office (WSO), which is newly established in each Wareda instead of the former Water Desk.

2-2-2 Basic Design (Construction / Equipment Plan)

2-2-2-1 Design Conditions

(1) Target Year

The design target year of the Project is 2010, as the Japan's Grant Aid scheme focuses on urgency of the project. The population growth rates in the last 10 years are very high in each proposed town, those ratios are expected to be decrease gradually and be steady. If a longer term were adopted for the design target year under such high population increase rate, there might be introduced overdesigned facilities. For these reasons, the target year has aimed at 2010.

(2) Designed Water Demand

1) Designed Water Supply Population

As no population census has been conducted since 1996 in Ethiopia, the most up-to-dated data on population and population growth rate is yet to publish. Therefore, the present population data were collected from AWRB and checked with the results of the socio-economic survey conducted in the Basic Design Study. Population data from the latest census in 1996 and the present population are shown in Table 2.2.1. In the census 1996, population of Gubi Dowra, Nemelefen, Wederage, and Kumami were not found because it was assumed that these towns had not yet existed at that time. Additionally, population of Divina town, which is located about 3 km away from Gubi Dowra was available, so the figure of 937 is assumed as the population of Gobi Dowra in 1996 in the table.

Table 2.2.1 Population Increase Rates in the Last 10 Years

Town Name	Population data in 1996 Census	Present Population in 2006	Annual Population Growth Rate (%)	Reference
1) Gubi Dowra	*937	1,500	18.7	A present population of Gubi Dowra and Divina towns is estimated at 5,200 in total then its annual population growth rate is estimated at 18.7%.
2) Kelewan	533	4,650	24.2	
3) Derayitu	154	3,650	37.2	
4) Chifra	1,660	6,510	14.6	
5) Eli Wuha	1,504	5,400	13.6	
6) Nemelefen	-	3,150	∞	
7) Wederage	-	3,450	∞	
8) Kumami	-	2,350	∞	
9) Dulecha	327	2,400	22.1	
Total		33,060		

*) Population of Divina town which is about 3 km away from Gubi Dowra town.

As shown in Table 2.2.1, the population growth rates in the last 10 years are ranged from 14 to 37%. These rates are extremely higher than the Ethiopian average population growth rate (3 %) in annum. Most of the above-mentioned towns were designated as Woreda Town during from 1996 to 2000, then various social infrastructures such as public administrative offices, schools, health clinics, hospitals and

so on have been constructed under a political cosideration. Gradually, the town population had been increased due to the social growth such as the emigrant for commercial purpose. And such trends are generally observed in every target towns. However, as annual population growth rates in the last five years are 8 to 10 % according to Woreda Councils and the key persons in each target town, it is expected that the population growth factor has been gradually changing from a social growth to a natural growth. Therefore the figure of population growth might decrease to a reasonable level in future.

In 2004, Afar Regional State has elaborated a water supply plan for six towns, which were prioritized to develop as principal towns of the state. Kelewan town was one of the project towns in it. Kelewan was the administrative center of the zone 4, and the town is relatively developed well. In this water supply plan, population growth rate is estimated at 8% for 2003 to 2010, 7%for 2010 to 2020 in Kelewan. As other 8 target towns of the project could be classified as the same type of town foundation as Kelewan, population growth rate of those towns are also assumed as almost the same. The figure 7% to 8% for growth rate is still comparatively higher than usual cases, so that there is a possibility of designing an exceeded scale of the facilities against the actually required capacity of each target town. Considering those conditions, 7% of the growth rate is adopted for the target towns except Gubi Dowra. For Gubi Dowra, considering a migration plan from neighbor towns, 8% of the growth rate is adopted.

Table 2.2.2 Population Forecast at Target Year

Town	Present Population in 2006	Population Growth Rate (%)	Forecasted Population	
			2010	2015
1) Gubi Dowra	1,500	8.0	2,041	2,999
2) Kelewan	4,650	7.0	6,095	8,549
3) Derayitu	3,650	7.0	4,784	6,710
4) Chifra	6,510	7.0	8,533	11,968
5) Eli Wuha	5,400	7.0	7,078	9,928
6) Nemelefen	3,150	7.0	4,129	5,791
7) Wederage	3,450	7.0	4,522	6,343
8) Kumami	2,350	7.0	3,080	4,320
9) Dulecha	2,400	7.0	3,146	4,412
total	33,060		45,418	63,035

2) Water Supply Coverage

Current water supply coverage of each target town has been estimated by the following manners then shown in Table2.2.3.

- Current water demand was estimated by multiplying the present population and the amount of water consumption, 25L per capita/day was adopted through the interview survey to the resident.
- Current water production volume was estimated by multiplying the operating time and the pump age of the existing facilities based on information from pump operator.
- Assumed current water supply coverage was calculated by dividing the current water demand into the current water production volume.

Table 2.2.3Current Water Supply Coverage in Target Towns

Town Name	Present population in 2006 A (person)	Daily consumption per capita B (L/cap/day)	Estimated daily consumption C=Ax B (m^3/day)	Existing wells			Estimated water supply coverage rate G=F/C (%)
				Yield D (L/sec)	Operation hours E (hours)	Production Amount F=DxE (m^3/day)	
1) Gubi Dowra	1,500	25	38	3.5	0.9	8	21.3
2) Kelewan	4,650	25	116	4.1	7.0	103	88.9
3) Derayitu	3,650	25	1	*3.5	6.0	76	83.5
4) Chifra	6,510	25	163	3.1	7.0	78	48.0
5) Eli Wuha	5,400	25	135	3.6	5.0	65	48.0
6) Nemelefen	3,150	25	79	1.5	6.0	32	41.1
7) Wederage	3,450	25	86	1.5	5.0	27	31.3
8) Kumami	2,350	25	59	-	none	-	0.0
9) Dulecha	2,400	25	60	1.8	3.0	19	32.4

*) Yield "D" of Delayitu town is adopted by referring the design report of the existing pump, because the pump was out of order during the field survey of the Basic Design.

Current water supply coverage rates were ranged from 21% in Gubi Dowra up to 89% in Kelewan. Current coverage rate can be classified into three groups as shown in Table 2.2.4, and the target coverage rates are presented in Table 2.2.4 as well. These target coverage rates are proposed, considering present coverage and Ethiopian national target of water supply coverage for urban that was set at 74% in 2011 by "WSDP 2001-2016".

Table 2.2.4 Current and Target Rate of Water Supply Coverage

Current Coverage Rate	Target Coverage Rate
Less than 39% (Gubi Dowra, Wederage, Dulecha, Kumami)	60%
Between 40 and 60% (Chifra, Eli Wuha, Nemelefen)	80%
Above 61% - (Kelewan, Derayitu)	100%

Water supply has been made through public fountain in the towns of Gubi Dowra, Derayitu, Dulecha, and through both public fountain and yard connection in the other towns. The yard connection users are estimated at 5-15% of the population at present, and the inhabitants are requesting to install yard connection in the most towns. For this reason, the change of service mode is forecasted as shown in Table 2.2.5.

Table 2.2.5 Proportion of Service Mode

Current Service Mode	Target Service Mode	
	Yard Connection	Public Fountain
Towns without yard connection (Gubi Dowra, Derayitu, Dulecha, Kumami)	10%	90%
Towns with yard connection and Public Fountain (Kelewan, Chifra, Eli Wuha, Nemelefen, Wederage)	20%	80%

3) Designed Daily Water Consumption per Capita

Designed daily water consumption per capita is classified in the following two types:

- Public fountain user: 25Liter/capita/day
- Yard connection user: 50Liter/capita/day

4) Designed Daily Average Supply Water

Designed daily average supply water is calculated by multiplication of the estimated population and the designed water consumption per capita. Additionally, 10% of the designed daily average supply water is added as the consumption of livestock.

5) Designed Daily Maximum Supply Water (DDMS)

Designed daily maximum supply water is derived from following formula.

DDMS = [Average daily consumption]÷[ratio of effective supply *[1]]÷[ratio of load *[2]]

*1,2) here,

Ratio of Effective Supply = 85%; (presumed a 15% of leakage ratio from distributing system)

Ratio of Load = 75%; (considering fluctuation of water supply volume along with the seasons)

Estimated water demand including above-mentioned numeric values and ratios are as shown in Table 2.2.6. The Government of Ethiopia has enacted Universal Access Program (UAP) in December 2005 as the latest water supply policy. In respect of water supply coverage, UAP aims to accomplish 100% in urban until 2010 by adopting 20 L/cpd of unit water consumption for inhabitants in urban. In accordance with the idea of UAP, daily supply water volumes for all the target towns were calculated by multiplication of 20 L and the present population and by adding 15% of average water supply volume as leakage water. As a result of the calculation, the designed daily maximum supply water are confirmed to cover the estimated ones by UAP's manners in each town as shown in Table 2.2.6

Table 2.2.6 Designed Water Demand (year of 2010)

Town	Present Population in 2010	Water Service Population			Daily Average Supply Water (m^3/day)		Designed Daily Maximum Supply Wate (m^3/day)	**Reference;** Estimated Daily Supply Water by UAP (m^3/day)
		Total Population served	Yard connection	Public fountain	Human	Human+ livestock		
1)Gubi Dowra	2,041	1,224	122	1102	33.7	37.0	58.1	48.0
2) Kelewan	6,095	6,095	1,219	4,876	182.9	201.1	315.5	143.4
3) Derayitu	4,784	4,784	478	4,306	131.6	144.7	227.0	112.6
4) Chifra	8,533	6,827	1,365	5,461	204.8	225.3	353.4	200.8
5) Eli Wuha	7,078	5,663	1,133	4,530	169.9	186.9	293.1	166.6
6) Nemelefen	4,129	3,303	661	2,643	99.1	109.0	171.0	97.2
7) Wederage	4,522	2,713	543	2,171	81.4	89.5	140.4	106.4
8) Kumami	3,080	1,848	185	1663	50.8	55.9	87.7	72.5
9) Dulecha	3,146	1,888	189	1699	51.9	57.1	89.6	74.0
Total	45,418	34,345			1,006.1	1,106.5	1,701.6	1,021.5

6) Designed Maximum Hourly Consumption

Designed maximum hourly consumption, numeric value needful for the pipeline designing, is given by the following formula.

$$Qh = K \times Qd/12$$

Qh ：Designed maximum hourly consumption (m^3/hour)
K ：Time coefficent
Qd ：Designed daily maximum supply water (m^3/day)

Although target sites are categorizes into “town” in Ethiopia, those towns are rather small considered its population. Therefore, time coefficient is assumed at 2.0.

(3) Designing of Well Facilities

1） Production Wells

The well pumps are basically designed to be outdoor type as same as the existing facilities, and the control panels of well pumps are designed to install inside control houses. The type of the well pumps is specified as submersible pump, and the specification of the pumps will be designed with the consideration of designed yields, dynamic groundwater levels in the wells, elevations of service reservoir, and pipeline losses. Solar pump system is technically incapable, as a result of technical calculation on power requirement of the pumps.

Operational hour of well pump is set at 8 or 10 hours per day considering present operational hours of the existing facilities and operator’s working conditions. This setting may enable a flexible operation of

the facilities in cases of a steep increase of water demand due to an unforeseen population growth or recurrent severe droughts, or other emergency incidences.

With respect to utilization of the existing wells as the future system, those will be run combined with newly installed facilities if those are judged as operational facilities. Designed pumpage (pumping rate) for the target towns are shown in Table 2.2.7, based on the result of test well drilling (see Table 1-2-6).

Table 2.2.7 Designed Pumpage

Town	Water demand			Pumpage (L/sec)		
	a) Daily demand (m^3/day)	b) Operational hours (hour/day)	c) Hourly demand (L/sec) c=a/b	d) Existing well	e) Test well (*)	f) Additional well
Gubi Dowra	58.1	8	2.0	1.0 not be used	not be used (1.0)	1.0
Kelewan	315.5	10	8.8	4.1	-	4.7
Derayitu	227.0	10	6.3	3.5 not be used	2.8 (3.0)	3.5
Chifra	353.4	10	9.8	3.1	6.7 (6.7)	-
Eli Wuha	293.1	10	8.1	3.6	4.5 (4.5)	-
Nemelefen	136.8	10	3.8	1.5	1.5 (1.5)	1.5
Wederage	140.5	10	3.9	1.5	1.2 (2.0)	1.2
Kumami	87.7	8	3.0	-	-	3.0
Dulecha	89.6	8	3.1	1.8	1.3 (6.7)	-

(*) Figures in parenthesis are optimum pumpages confirmed by Basic Design Study (see Table 1-2-6)

As the existing well in Derayitu town was supposed to be curvature depending on the reports of pump repair in the past, this well is jugged not to use as the project, a new deepwell will be drilled along the existing transmission pipeline instead. In case of Gubi Dowra town, the groundwater has 40℃ water temperature, high concentration of total dissolved solids, and some minerals due to the effect of volcanic activities. According to the water quality analysis, the groundwater of test well showed excessive contents of Sodium (465mg/L) and Fluoride (5.75mg/L) against the Ethiopian guideline for drinking water quality, which provides 358mg/L for Sodium and 3mg/L for Fluoride. Though Sodium dose not affect directly to human health, Fluoride is reported to develop the symptom of skeletal fluorisis, if its content is over 3 mg/L in the potable water. The test well in Gubi Dowra therefore should be abandoned. However, concerning the existing well, the contents of Sodium (320mg/L) and Fluoride (1.1mg/L) are lower than the guideline values. Therefore, it is effective to use the same aquifer of the existing well as a water source of the proposed facilities. The structural reliability of the existing well is uncertain because no data has been available for evaluating the well. Consequently a new well is designed to drill near the existing well so that the same groundwater can be pumped and conveyed to a designed reservoir. As the designed pumpage of the new well is estimated at 1.0L/sec, which covers a

half of the designed water demand, the system needs two deep wells. However, it is too difficult to decide the drilling point that is free from the risk of Fluoride content, because the points with Fluoride are dotted in the surrounding area. Consequently, one deep well is decided to drill and supply 29 m^3/day of groundwater to the Gubi Dowra town. This supply water volume is estimated at 3.5 times as much as the present one, so the water supply conditions are expected to improve considerably.

2) Submersible Motor Pump

Axial power of submersible pump is given by the following formula.

$$P = 0.163 \times \gamma \times Q \times H \times \frac{(1+\alpha)}{\eta}$$

P : Axial power of pump (kW)
γ : unit weight of water (1.0kg/L)
Q : yield of well (m^3/sec)
H : total head (m)
α : marginal factor (15%)
η : pump efficiency (40%)

For the calculation, a 3.0m of head loss shall be added to the total head taking friction losses of bends, valve, and other pipe-fittings around the pump into account.

3) Electric Generator

Capacity of electric generator is given by following formula considering instantaneous voltage drop at the time of starting of the load of electric motor.

$$PG = \frac{Xd'(1-\Delta V)}{\Delta V} \times Pm \times \beta \times C$$

PG : Generating Capacity (kVA)
Xd' : Transient Reactance of Generator (0.2)
ΔV : Instantenous Voltage Drop (0.3)
Pm : Power of Motor (kW)
β : Starting of the load of electric motor (kVA)
C : Factor motor starter (Direct-on-line type; 1.0, Star-delta type; 0.67)

(4) Designing of Water Conveyance Facility

Basically, capacity of water conveyance pipe is designed to meet the well yield. For calculation of water head loss, Hazen-Willlams formula is adopted as follows.

$$H=10.666\times C^{-1.85}\times D^{-4.87}\times Q^{1.85}\times L$$

H：Friction loss (m)

C：Coefficient of flow rate (C=110)

D：Pipe Inner Diameter (m)

Q：Flow Quantity (m^3/sec)

L：Length of Pipeline (m)

(5) Designing of Water Distribution Facilities

1) Service Reservoir

Storage capacity of service reservoir is basically set at 12 hours amount of the designed daily maximum supply water in 2010. In case of elevated tank, capacity will be set at 8 hours amount of the same to avoid excessive designing.

In Ethiopia, reservoirs are standardized for at ones of $50m^3$, $75m^3$, and $100m^3$ for effective design process. Therefore design of the proposed reservoir is adopted the standardized structure. Storage capacities of designed reservoirs for the target sites are as shown in Table 2.2.8.

Table 2.2.8 Storage Capacity of Reservoir in Target Sites

Town	Daily Maximum Supply Water (m^3/day)	Required Storage Capacity (m^3)	Existing Reservoir Capacity (m^3)	Additionally Needed Capacity (m^3)	Type of Reservoir
Gubi Dowra	58.1	29	—	50	Ground Reservoir
Kelewan	315.5	158	50	100	Ground Reservoir
Derayitu	227.0	76	35	50	Elevated Tank
Chifra	353.4	177	50	130	Ground Reservoir
Eli Wuha	293.1	147	50	100	Ground Reservoir
Nemelefen	136.8	68	50	50	Ground Reservoir
Wederage	140.5	47	50	—	Elevated Tank
Kumami	87.7	44	—	50	Ground Reservoir
Dulecha	89.6	30	50	—	Elevated Tank

2) Distribution Pipeline

Distribution pipeline are basically installed along the main road of the town. Only Kelewan town has a town planning elaborated by the Afar State Government among the 9 target towns, so that some secondary distribution pipeline can be laid along the planned road. In other towns where town blocks and roads arrangement are vague, pipelines will be mainly laid along only the main roads. Pipe diameter will be set to make inner pipe pressure between 0.5-6.0 kg/cm^2.

3) Public Fountain

Distance between public fountains shall be within 500m to avoid rushing to one fountain. A water

trough for livestock will be installed in Eli Wuha town, because many pastoralists visit everyday to fetch leaked water from the existing water conveyance pipeline and water their livestock.

2-2-2-2 Construction Plan of Facilities

Planned water supply facilities consist of deepwell, water conveyance, water distribution and electric generator facilities, etc. in the Project. Planned facilities are summarized as shown in Figure2.2.1. Bill of quantities and the specifications are summarized in Table 2.2.9.

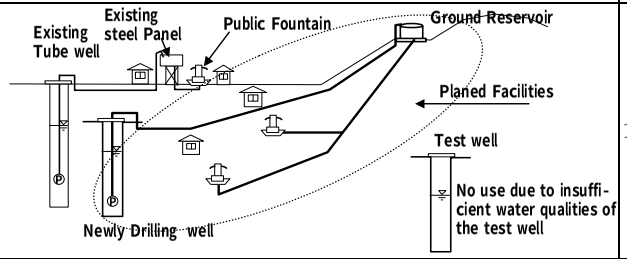
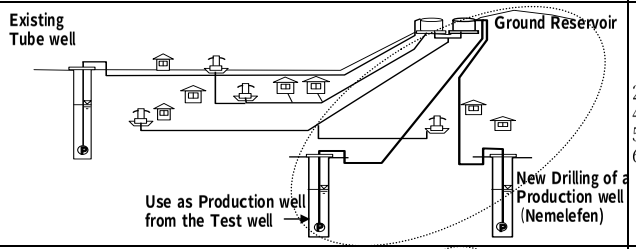
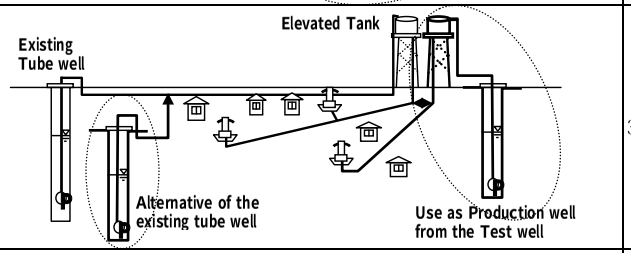
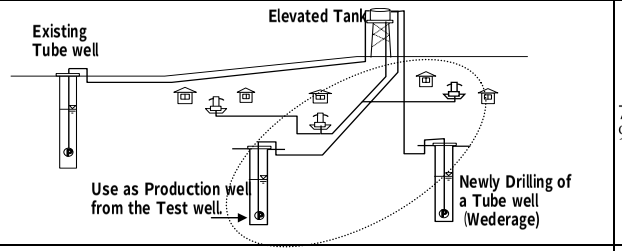
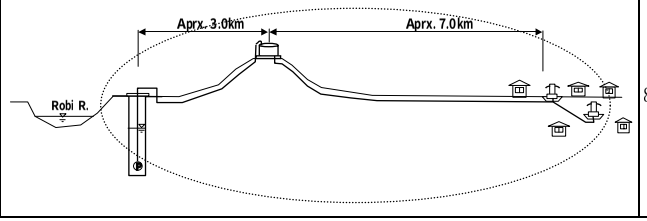
	General Plan of Water Supply Facilities		Existing Facilities	Planed Facilities	Reference
1		1) Gubi Dowra	1) Tube Well (Mono pump + Diesel Engine) 1 set. 2) Transmission main φ50mm 3) Steel Panel Tank (H=2m, V=4m3) 1 set. 4) Public Fountain 1set.	1) Newly Tube Well Drilling 1No. (As the Replacements of the Existing Well) 2) Transmission main φ63mm 3) Reservoir (Concrete made, V=50m^3) 4) Water Distribution Pipeline, Public Faucets : 5 sets.	Due to insufficient groundwater qualities, the test well was abandon to use as a production well. Though the existing well produces a tolerable quality water, its reliability for permanent use was doubted due to no availability of the relevant data. Accordingly a new production well is designed to drill near the existing well so that the same groundwater can be pumped out and sent to the desigded reservoir.
2		2) Kelewan 4) Chifra 5) Eli Wuha 6) Nemelefen	1) Tube Well (Submersible pump + Diesel Engine Generator) 1 set. 2) Transmission main φ60-75mm 3) Ground reservoir (Concrete made, V=50m^3) 1 set. 4) Public Fountain 4 sets. (1 no. is out of order)	1) Tube Well (Reuse the test well as a production well) 1No. 2) Transmission main φ75-100mm 3) Reservoir (Concrete made, V=50-130m^3) 4) Water Distribution Pipeline, Public Faucets : 3-5 sets. 5) Newly Tube well Drilling : 1well for Nemelefen	As a total water amount to be pumped from the existing well and the test well is not enough to cater the water demand in Nemelefen, an additional well is designed to drill. In Kelewan, as a test well could not be drilled in the Basic Design Study, a production well is also designed to drill at a place recommended by the results of geological survey done in the Basic Design Study.
3		3) Derayitu	1) Tube Well (Mono pump + Diesel Engine) 1 set. 2) Transmission main φ75mm 3) Elevated Tank (H=6m, Steel Panel V=40m^3) 1 set. 4) Public Fountain 3 sets. (1 no. is out of order)	1) Tube Well (Reuse the test well as a production well) 1No. 2) Transmission main φ75mm 3) Elevated Tank (Concrete made, H=6m, V=50m^3) 4) Water Distribution Pipeline, Public Faucets : 3 pies. 5) New Tube well Drilling : 1 No. (as a substitute of the existing tube well)	As the existing well was supposed to be curvature or damaged by parts of pump falled etc., the wll is being used in spite of an intermittente function. This well can be used only for an emergency use. An additional well is designed to drill along the existing transmission pipeline as the substitution for the existing one.
4		7) Wederage 9) Dulecha	1) Tube Well (Submersible pump + Diesel Engine Generator) 1 set. 2) Transmission main φ50mm 3) Elevated Tank (Concrete made, H=6m, V=50m^3) 1 set. 4) Public Fountain 2-3 sets.	1) Tube Well (Reuse the test well as a production well) 1No. 2) Transmission main φ50mm 3) Water Distribution Pipeline, Public Faucets : 2 saets. 4) Newly Tube well Drilling : 1well for Wederage	
5		8) Kumami	—	1) New Tube Well Drilling : 1No. 2) Transmission main φ75mm 3) Ground reservoir (Concrete made, V=50m^3) 4) Water conveyance main φ100-125mm 5) Water Distribution Pipeline, Public Faucets : 3 sets.	A new production well is designed to drill near the Robi river intending to pump up groundwater by mixture of permeable water from the river bed.

Fig. 2.2.1 Concept of Planed Water Supply Facilities

Table 2.2.9 List of Proposed Facilities for the Project Sites

				Gubi Dowra	Kelewan	Derayitu	Chifra	Eli Wuha	Nemelefen	Waderage	Kumami	Dulecha	total Nos.	Equipment for Procurement Plan
Intake Facilities	Production Well	Rehabilitation of well		1 No. (to be abandoned)	1 No.	1 No. (to be abandoned)	1 (to be rehabilitated)	1 No.	1 N0.	1 No. (to be rehabilitated)	-	1 No.	6Nos.	
		Reuse of Test well as Production well		1No. (148m deep, to be abandoned)	-	1No. (63m deep)	1No. (99m deep)	1No. (130m deep)	1No. (61m deep)	1No. (110m deep)	-	1No. (78m deep)	6Nos.	
		Construction of new well		1No.(148m deep as a replacement for the exist well)	1No. (130m deep)	1No.(63m deep as a replacement for the exist well)	-	-	1No. (61m deep)	1No. (110m)	1No. (60m deep)	-	6Nos.	
		Total		1Nos.	2No.	2Nos.	2Nos.	2Nos.	3Nos.	3Nos.	1No.	2No.	18Nos.	
	Submersible Pumps (Frame colored are new ones)	Existing Well		To be abandoned	Q=0.246m³/min H=129m	To be abandoned	Q=0.186m³/min H=108m 6.1kW	Q=0.216m³/min H=186m	Q=0.090m³/min H=88m	Q=0.090m³/min H=118m 3.2kW	-	Q=0.108m³/min H=100m	2 sets for replacement of existing pumps	Q=0.138m³/min H=112m 4.7kW
		Proposed Well 1		-	Q=0.279m³/min H=112m 9.4kW	Q=0.168m³/min H=67m 3.4kW	Q=0.402m³/min H=96m 11.6kW	Q=0.270m³/min H=139m 11.3kW	Q=0.09m³/min H=112m 3.0kW	Q=0.072m³/min H=112m 2.4kW	Q=0.186m³/min H=247m 13.8kW	Q=0.077m³/min H=122m 2.9kW	8sets	Q=0.318m³/min H=138m 13.2kW
		Proposed Well 2		Q=0.06m³/min H=163m 2.9kW	-	Q=0.21m³/min H=68m 4.3kW	-	-	Q=0.09m³/min H=115m 3.1kW	Q=0.072m³/min H=126m 2.7kW	-	-	4sets	
	Installation of new generator set	17KVA		1No.	-	1No.	-	-	1No.	2Nos.	-	1No.	6Nos.	
		23KVA		-	-	1No.	-	-	1No.	-	-	-	2Nos.	
		28KVA		-	1No.	-	1Nos.		-	-	-	-	2Nos.	
		37KVA			-	-	-	1No.			1No.		2No.	1No.
		Generator house		1No.	1No.	2Nos.	1No.	1No.	2Nos.	2Nos.	1No.	1No.	12Nos.	
Transmission Facilities	Transmission pipeline	ϕ50mm		-	-	-	-	-	-	1850m	-	1210m	3060m	
		ϕ63mm		1170m	-	-	-	-	4630m	-	-	-	5800m	
		ϕ75mm		-	1280m	1170m	-	-	-	-	3030m	-	5480m	
		ϕ75mm (Replacement)		-	-	-	1190m	-	-	-	-	-	1190m	
		ϕ100mm		-	-	-	650m	5100m	-	-	-	-	5750m	
	Total Length			1170m	1280m	1170m	1840m	5100m	4630m	1850m	3030m	1210m	21280m	
	Air Valve	Existing pipeline	ϕ50mm	-	-	-	-	-	-	-	-	1No.	1No.	
			ϕ63mm	-	3Nos.	-	-	-	1No.	1No.	-	-	5Nos.	
			ϕ75mm	-	-	1No.	3Nos.	6Nos.	-	-	-	-	10Nos.	
		New laying or Replacement	ϕ50mm	-	-	-	-	-	-	2Nos.	-	1No.	3Nos.	
			ϕ63mm	-	-	-	-	-	4Nos.	-	-	-	4Nos.	
			ϕ75mm	-	3Nos.	1No.	-	-	-	-	3Nos.	-	7Nos.	
			ϕ100mm	-	-	-	1Nos.	6Nos.	-	-	-	-	7Nos.	
	Drain valve	Existing pipeline	ϕ50mm	-	-	-	-	-	-	1No.	-	1No.	2Nos.	
			ϕ63mm	-	3Nos.	-	-	-	2Nos.	-	-	-	5Nos.	
			ϕ75mm	-	-	1No.	2Nos.	5Nos.	-	-	-		8Nos.	
		New laying or Replacement	ϕ50mm	-	-	-	-	-	-	2Nos.	-	1No.	3Nos.	
			ϕ63mm	1Nos.	-	-	-	-	4Nos.	-	-		5Nos.	
			ϕ75mm	-	3Nos.	1No.	-	-	-	-	3Nos.	1No.	8Nos.	
			ϕ100mm	-	-	-	1Nos.	5Nos.	-	-	-	-	6Nos.	
	Valve Pit			1Nos.	12Nos.	4Nos.	7Nos.	22Nos.	11Nos.	6Nos.	6Nos.	5Nos.	74Nos.	
Distribution Facilities	Reservoir	Ground 50m³		1No.	—	—	—	—	1No.	—	1No.	—	3Nos.	
		Ground 100m³		—	1No.	—	—	1No.	—	—	—	—	2Nos.	
		Ground 130m³		—	—	—	1No.	—	—	—	—	—	1No.	
		Elevated 50m³		—	—	1No.	—	—	—	—	—	—	1No.	
	Distribution pipeline	ϕ50mm		550m	70m	—	-	-	640m	-	-	420m	1680m	
		ϕ63mm		460m	-	-	-	-	350m	390m	460m	160m	1820m	
		ϕ75mm		—	860m	-	990m	740m	250m	-	-	-	2840m	
		ϕ100mm		—	80m	330m	980m	740m	280m	200m	4300m	180m	7090m	
		ϕ125mm		-	290m		570m	-	-	400m	2730m	280m	4270m	
		ϕ150mm		-	590m	760m	-	690m	-	-	-		2040m	
	Total Length			1010m	1890m	1090m	2540m	2170m	1520m	990m	7490m	1040m	19740m	
	Public Faucet			5Places	2Places	3Places	5Places	3Places	3Places	2Places	3Places	2Places	28Places	
	Air Valve	ϕ50mm		1No.	1No.	-	-	-	1No.	-	-	-	3Nos.	
		ϕ63mm		-	-	-	-	-	2Nos.	-	1No.	-	3Nos.	
		ϕ75mm		-	1No.	-	3Nos.	3Nos.	1No.	-	-	-	8Nos.	
		ϕ100mm		-	-	-	1No.	3Nos.	-	1No.	4Nos.	1No.	10Nos.	
		ϕ125mm		-	1No.	-	2Nos.	-	-	1No.	3Nos.		7Nos.	
		ϕ150mm		-	-	1No.	-	1No.	-	-			2Nos.	
	Drain Valve	ϕ50mm		1No.	-	-	-	-	1No.	-	-	1No.	3Nos.	
		ϕ63mm		-	-	-	-	-	2Nos.	1No.	1No.	1No.	5Nos.	
		ϕ75mm		-	2Nos.	-	3Nos.	3Nos.	1No.	-	-	-	9Nos.	
		ϕ100mm		-	-	1No.	1No.	2Nos.	-	-	4Nos.	-	8Nos.	
		ϕ125mm				-	1No.	-	-	-	3Nos.	-	4Nos.	
		ϕ150mm				-	-	1No.	-	-		-	1No.	
	Sluice Valve	ϕ50mm		2Nos.	1No.	-	-	-	1No.	-	-	1No.	5Nos.	
		ϕ63mm		-	-	-	-	-	1No.	1No.	1No.	1No.	4Nos.	
		ϕ75mm		-	3Nos.	-	2Nos.	2Nos.	1No.	-	-	-	8Nos.	
		ϕ100mm		-	1No.	1No.	1No.	2Nos.	-	-	-	-	5Nos.	
		ϕ125mm		-	1No.	-	-	-	-	-	-	-	1No.	
	Valve Pit			4Nos.	11Nos.	3Nos.	14Nos.	17Nos.	11Nos.	4Nos.	17Nos.	5Nos.	86Nos.	
	Water trough for livestock			-	-	-	-	1	-	-	-	-	1Nos.	

2-2-2-3 Equipment Plan

(1) Component of the Equipment to be procured

Concerning cased well, there are 140 wells in total that is divided into 40 deep wells and 100 shallow wells in Afar region at present. AWRB has kept on constructing shallow wells and deepwells along with the national development plan.

Among those existing wells, more than 30 wells including the wells with the depth of more than 100m have been malfunctioned wells, and AWRB has formulated a rehabilitation plan for those wells including future rehabilitation activities. According to its plan, AWRB has planned to carry out rehabilitation of 30 malfunctioned wells for 2 years. However, as AWRB has only one service rig with the working capability less than 100m depth, it is difficult to carry out the works with one service rig. For this reason, AWRB has requested the Government of Japan to procure the equipment necessary for the well rehabilitation and pumping test.

According to the plan, AWRB has aimed to conduct the rehabilitation work by means of high-velocity-jetting method to eliminate the scales from slits of the screen of wells. As shown in Table 2.2.10, the requested equipments are divided into two components by its usage: 1) vehicle with the equipment necessary for high-velocity-jetting work, 2) vehicle with the equipment necessary for the pumping test. Truck crane can conduct high-velocity-jetting work, but it is needed for some arrangements of the carrier in order to carry machinery, tools, and materials. The equipment for the pumping test includes two submersible motor pumps, one generator, one water measurement box with V-shape notch, one portable water analysis kit, etc.

Table 2.2.10 Equipment Requested by AWRB

Equipment	Purpose
1. Long-body cargo truck with crane for high-velocity-jetting work including the equipments	• To carry the machinery, tools, and materials necessary for high-velocity-jetting work. • To install and withdraw the high-velocity-jetting tools. • To carry out high-velocity-jetting work.
2. Medium-body cargo truck with crane for the pumping test including the equipments	• To carry the machinery, tools, and materials necessary for the pumping test. • To install and withdraw the submersible motor pump. • To carry out pumping test. • To carry out on-site water quality test.

⑵ Long-body cargo truck with crane for High-velocity-jetting Work

1) Payload of the Truck and Lifting Capacities of the Crane

Long-body cargo truck with crane will be used to transport crane carries machinery, work tools, materials necessary for high-velocity-jetting work, sets up compressor, air-lift-pipes, etc. for the implementation of the work. The truck is equipped with the machinery such as compressor, generator, winch, tri-pole, etc. A total weight of the equipment is estimated at approximately 5.5 tons as shown in Table 2.2.11, so the required loading capacity is set at 10 tons including some

marginal loading capacities.

The required lifting capacity of the crane is 3 tons, considering the compressor with a weight of 1.0 ton, the heaviest one among the equipment and working condition of the crane's boom.

Table 2.2.11 Equipment to be loaded on Cargo for High-velocity-jetting Work

Equipment to be loaded on the Cargo	Weight (kg)
Compressor (Rated pressure 0.69MPa x air delivery 5.1m^3/min x 1set)	950
Accessories for air-lifting work (air-lift pipe, pipe-coupling, jetting nozzle, etc.)	3,700
Generator (6.5KVA)	460
Winch (400kgf, L=170m)	100
Others (bailers, barrels)	300
Total	5,510

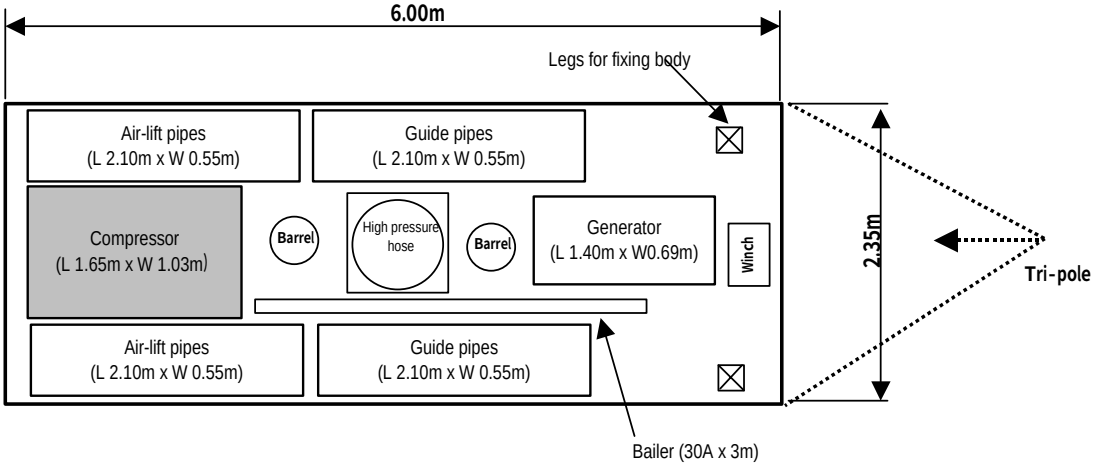


Fig 2.2.2 Layout of the Equipment to be loaded on Long Cargo

2) Truck

Long-body cargo truck shall be 6 x 4 drive type.

(3) Medium-body cargo truck with crane for Pumping Test

1) Payload of the Truck and Lifting Capacities of the Crane

Medium-body cargo truck with crane carries machinery, tools, and materials necessary for pumping test, and sets up generator, submersible motor pumps, water measurement box, etc. for the implementation of the work. A total weight of the equipment for pumping test is estimated at approximately 3.4 tons as shown in Table 2.2.12, then the required loading capacity is set at 6.0 tons in consideration of some reserves.

The required lifting capacity of the crane is 3 tons, considering the generator with a weight of 1.18 tons that is the heaviest among the equipment and working condition of the crane's boom.

Table 2.2.12 Equipment to be loaded on the Cargo for the Pumping Test

Equipment to be loaded on the Cargo	Weight (kg)
Submersible motor pump (Head 100m x Flow 138L/min. x 1set, Head 100m x Flow 318L/min. x 1set)	260
Accessories for pumping test (Flexible riser pipe, Elbow pipe, valves, Cables, Control panel, etc)	870
Diesel generator for pumping test (37KVA, L 2.0m x W 0.9m x H 1.3m)	1,180
Three drums including fuel	720
Water measurement box (L 2.2m x B 0.6m)	400
Total	3,430

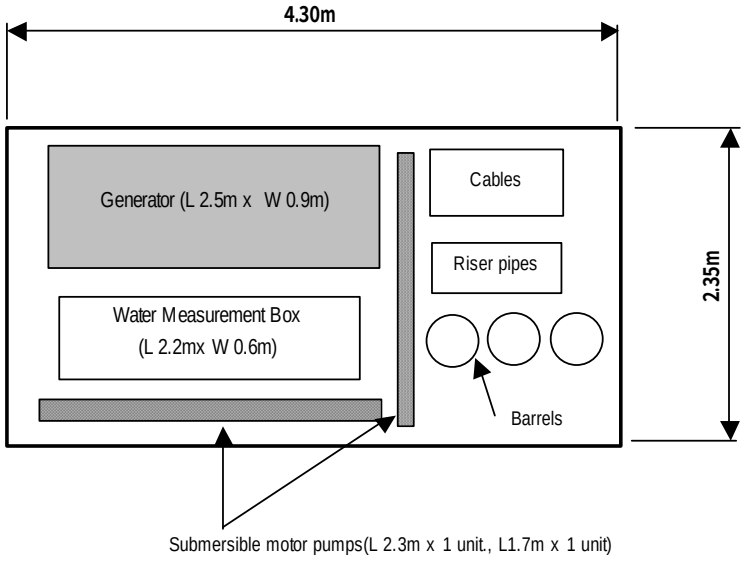


Fig.2.2.3 Layout of the Equipment to be loaded on Medium Cargo

2) Truck

Medium-body cargo truck shall be 4 x 4 drive type.

(4) Equipment for Pumping Test

1) Submersible Motor Pump: 2 lots

The capacity of submersible motor pumps for the pumping test is 1.5 times as much as the pumpage of the existing wells. The pumpage of the existing wells including the test wells is divided into two ranges: 1) from 0.7 to 1.5L/sec. and 2) from 2.0 to 3.5L/sec. Two submersible motor pumps with the specifications of 1) 2.3 L/sec x 100m head and 2) 5.3 L/sec x 100m head are recommended, because maximum dynamic water level is expected as 100m. In addition, flexible pipe reinforced with glass-fiber is recommended for the riser pipe, considering working efficiency of

setting up of riser pipes.

2) Diesel Generator: 1 lot

Diesel engine generator for the pumping test shall be with the capacity of 37KVA in order to operate above-mentioned submersible motor pumps whose estimated output is 13kW.

3) Water-measure Box: 1 lot

Water measurement box shall be with 90 ° V-shape notch capable of measure water flow, and the size shall be as follows.

Size： L 2,200mm x W 600mm x D 500mm

4) Water Level Detector: 2 lots

Water level detector is to measure static and dynamic water levels in the events of pumping test and monitoring work. The capable depth of the detector shall be not less than 150m.

5) Portable Water Quality Analysis Kit: 1 lot

Portable water quality analysis kit is to grasp water quality on site, and shall be portable type and measures following parameters.

- pH,
- Electric conductivity/TDS,
- Faecal Coliform,
- Chlorine,
- Nitrates,
- Nitrites,
- Ammonia,
- Fluorides,
- Arsenic.

Table 2.2.13 Summary of the Equipment to be Procured

Equipment		Q'ty	Specification
1) Long-body Cargo Truck with Crane for high-velocity-jetting work including the equipment	i) Long-body Cargo Truck with Crane	1 set	Drive : 6x4 Pay load : 10 tons Carrier length : Not less than 6.0 m Lifting capacity (Crane) : 3tons Left Handle
	ii) Compressor	1 set	Fixed on cargo, rated pressure 0.69MPa , air delivery 5.1m^3/min
	iii) Accessories for air-lifting work	1 lot	Air-lift pipe, pipe-coupling, jetting nozzle, etc.
	iv) Generator	1 set	6.5KVA
	v) Winch	1 set	400kgf, L=170m
	vi) Bailers	1 lot	100A x 3m
2) Medium-body Cargo Truck with Crane for the pumping test including the equipment	i) Medium-body Cargo Truck with Crane	1 lot	Drive : 4x4 Pay load : 6.0 tons Carrier length : Not less than 4.3 m Crane capacity : 3 tons Left Handle
	ii) Submersible motor pumps	2 lots	Head 112m×Quantity 2.3L/sec.×1set Head 140m×Quantity 5.3L/sec.×1set
	iii) Generator	1 lot	Air-cooling system, 37ｋVA
	iv) Water measurement box	1 lot	L 2, 200mm x W 600mm x D 500mm
	v) Water level detector	2 lots	Buzzor sencor, depth 150m
	vi) Portable water quality analysis kit	1 lot	Portable type, parameters to be analyzed(pH、electric conductivity/TDS 、Faecal Coliform, Chlorine, Nitrates, Nitrites, Ammonia, Fluorides, Arsenic.
3) Spare parts	i. Medium-body Cargo Truck with Crane	1 Lot	For 2 years operation
	ii. Medium-body Cargo Truck with Crane	1 Lot	For 2 years operation
	iii. Submersible motor pump	1 Lot	For 2 years operation
	v. Generator	1 Lot	For 2 years operation

2-2-3 Basic Design Drawing

Basic drawings of water supply facilities for the project are as follows.

- Fig. 2.2.4 Layout Plan of Water Supply Facilities in Gubi Dowra
- Fig. 2.2.5 Layout Plan of Water Supply Facilities in Kelewan
- Fig. 2.2.6 Layout Plan of Water Supply Facilities in Derayitu
- Fig. 2.2.7 Layout Plan of Water Supply Facilities in Chifra
- Fig. 2.2.8 Layout Plan of Water Supply Facilities in Eli Wuha
- Fig. 2.2.9 Layout Plan of Water Supply Facilities in Nemelefen
- Fig. 2.2.10 Layout Plan of Water Supply Facilities in Wederage
- Fig. 2.2.11 Layout Plan of Water Supply Facilities in Kumami (i)
- Fig. 2.2.12 Layout Plan of Water Supply Facilities in Kumami (ii)
- Fig. 2.2.13 Layout Plan of Water Supply Facilities in Delecha
- Fig. 2.2.14 Drawing of Typical Structure of Production Well
- Fig. 2.2.15 Typical Pipe Arrangement Around Well
- Fig. 2.2.16 Structural Drawing of Generator House
- Fig. 2.2.17 Structural Drawing of Service Reservoirs
- Fig. 2.2.18 Structural Drawing of Elevated Tank
- Fig. 2.2.19 Drawing of Pipe laying and Chambers
- Fig. 2.2.20 Typical Structure of Public Fountain
- Fig. 2.2.21 Typical Structure of Water Trough for Livestock

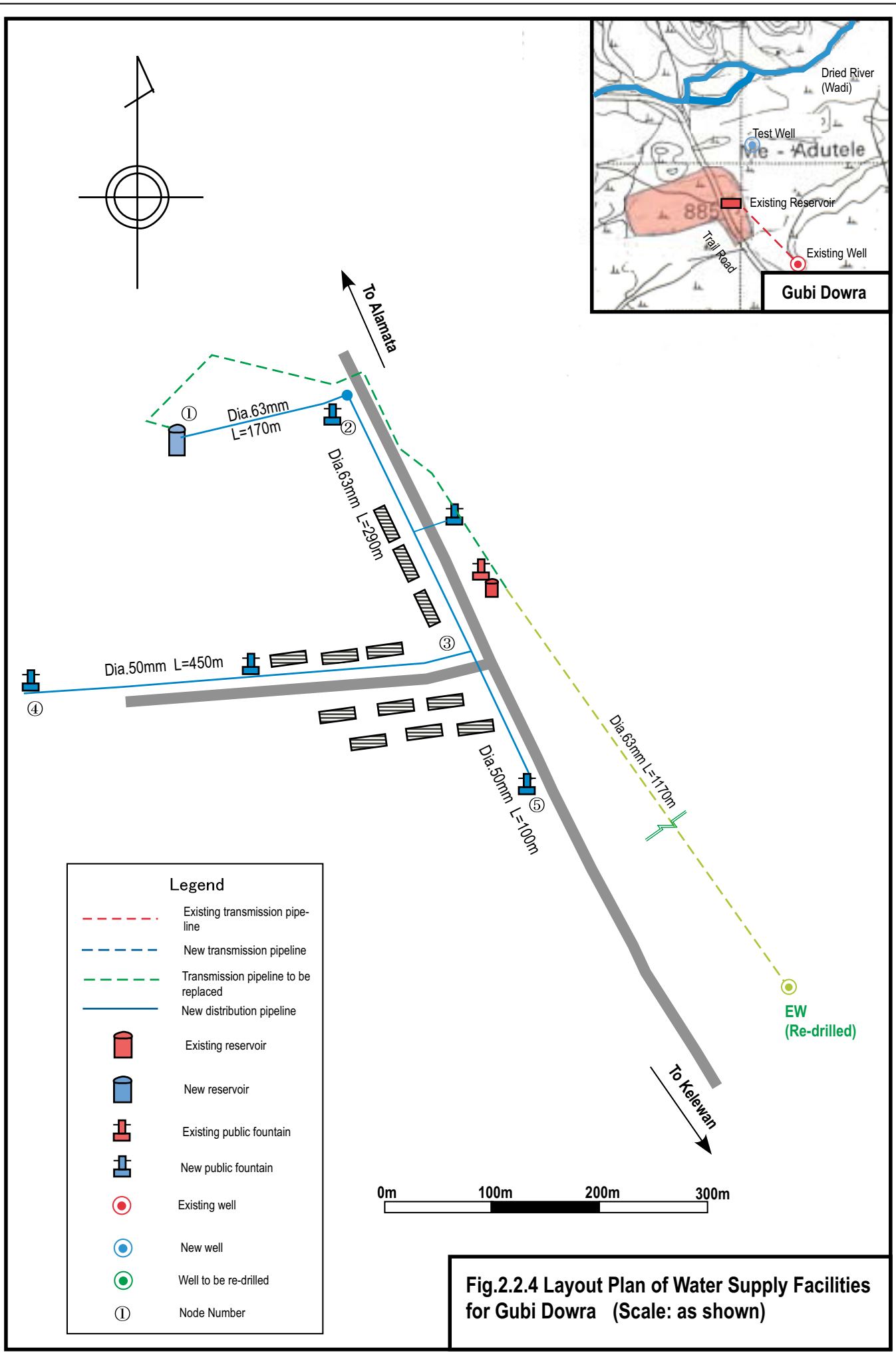


Fig.2.2.4 Layout Plan of Water Supply Facilities for Gubi Dowra (Scale: as shown)

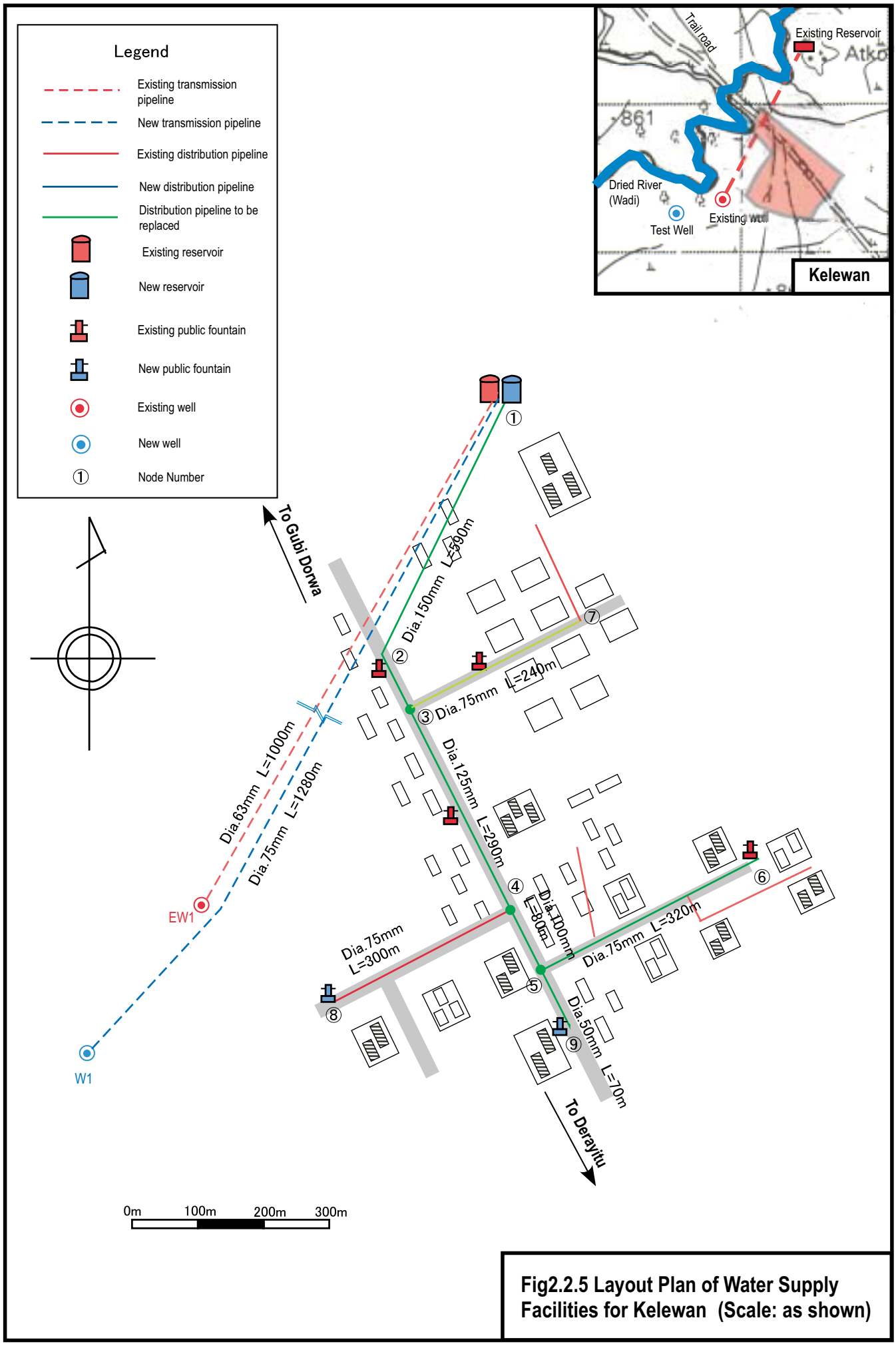
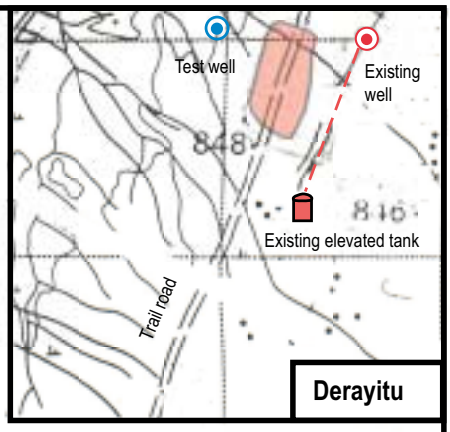
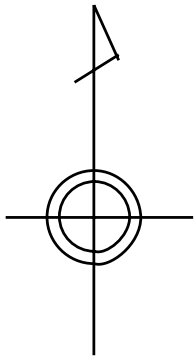
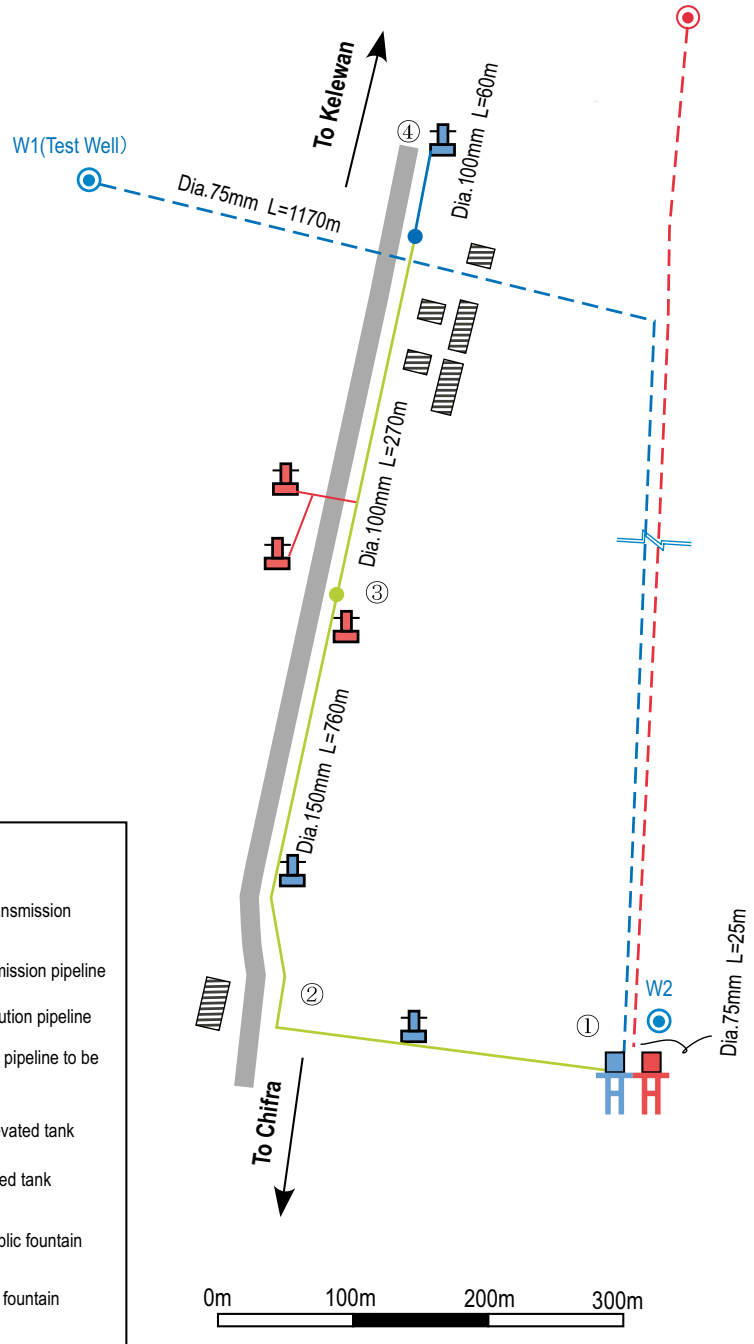


Fig2.2.5 Layout Plan of Water Supply Facilities for Kelewan (Scale: as shown)







Legend

- Existing transmission pipeline
- New transmission pipeline
- New distribution pipeline
- Distribution pipeline to be replaced
- Existing elevated tank
- New elevated tank
- Existing public fountain
- New public fountain
- Well to be re-drilled
- New well
- ① Node Number

Fig.2.2.6 Layout Plan of Water Supply Facilities for Derayitu (Scale: as shown)

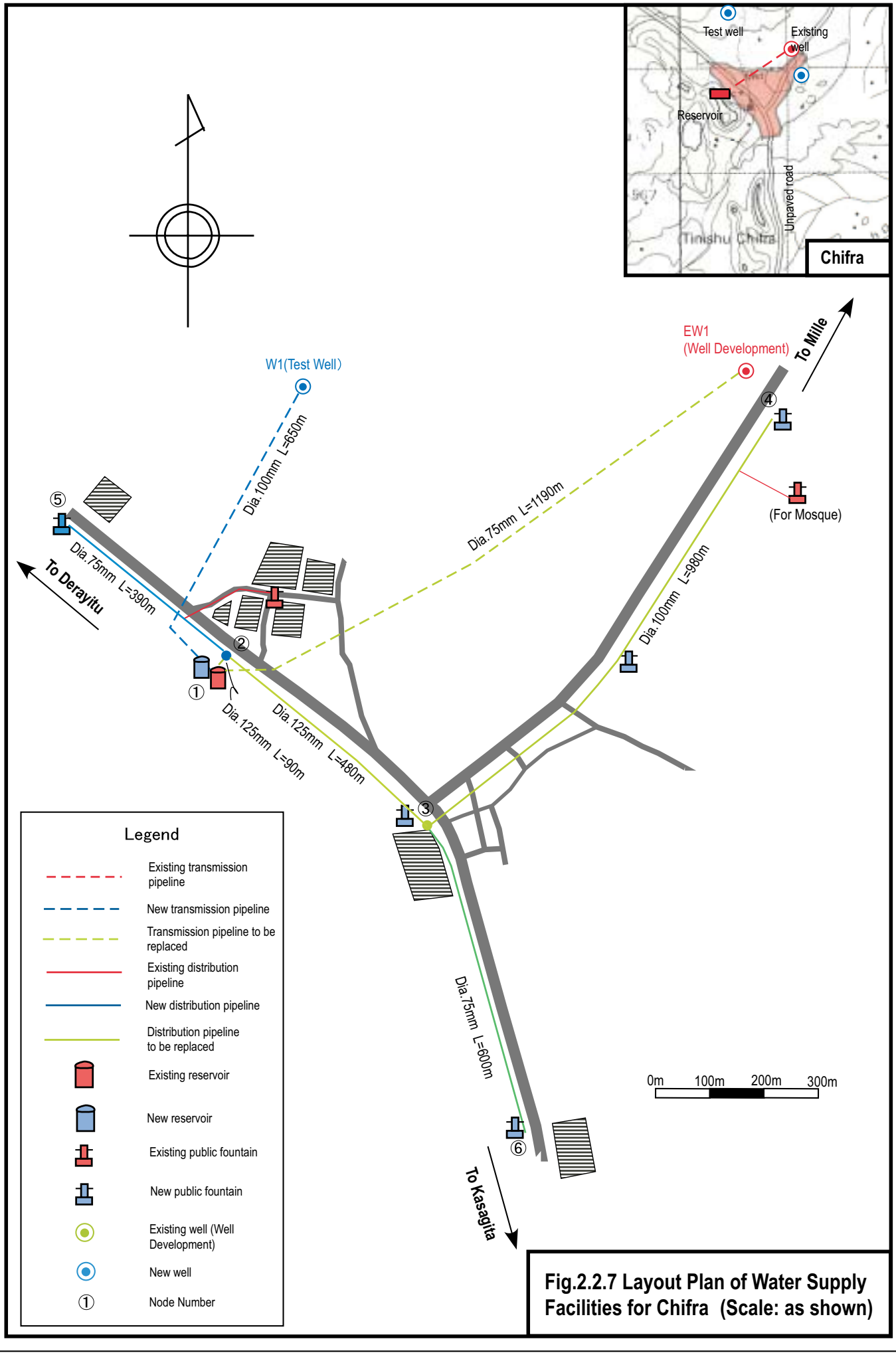


Fig.2.2.7 Layout Plan of Water Supply Facilities for Chifra (Scale: as shown)

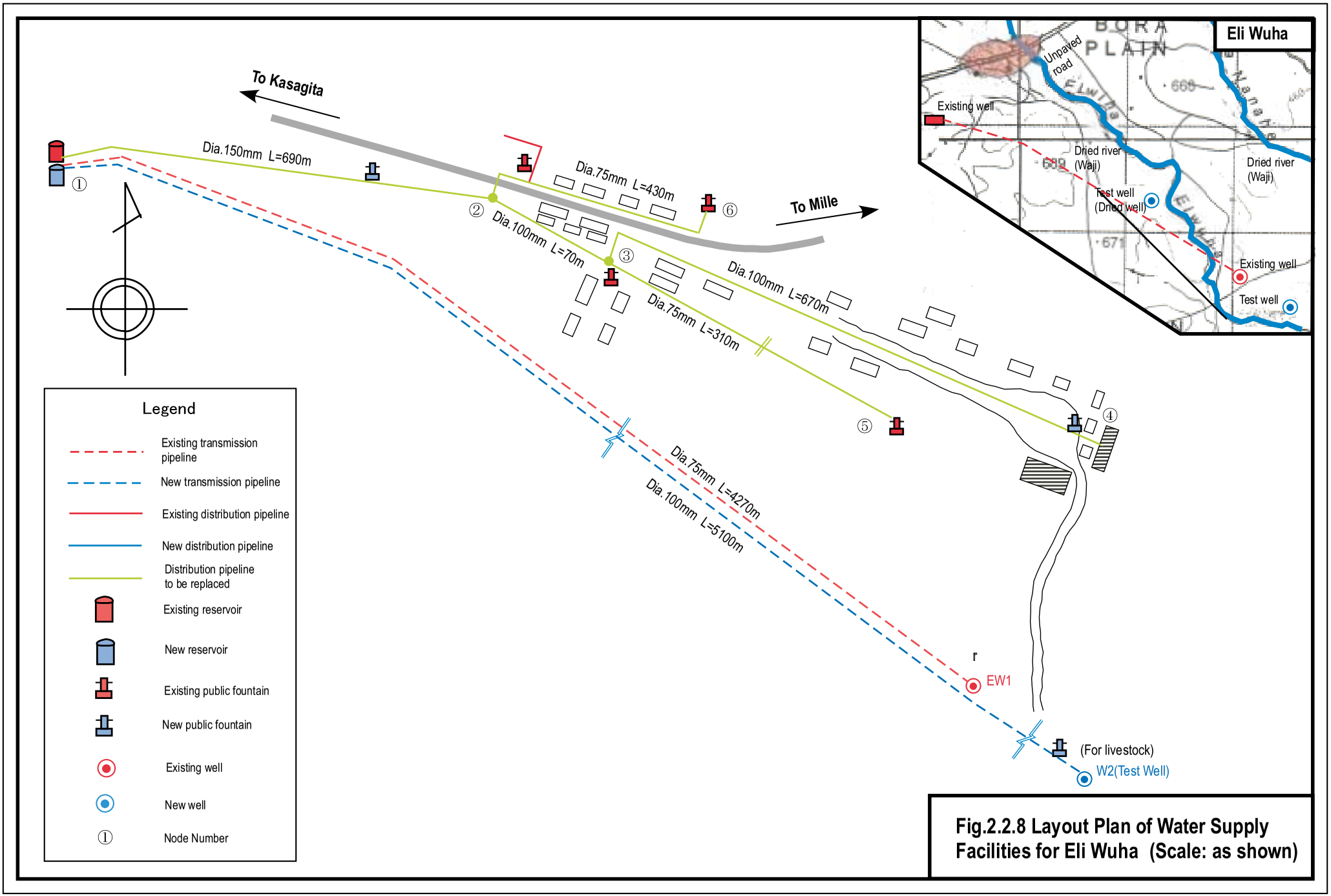


Fig.2.2.8 Layout Plan of Water Supply Facilities for Eli Wuha (Scale: as shown)

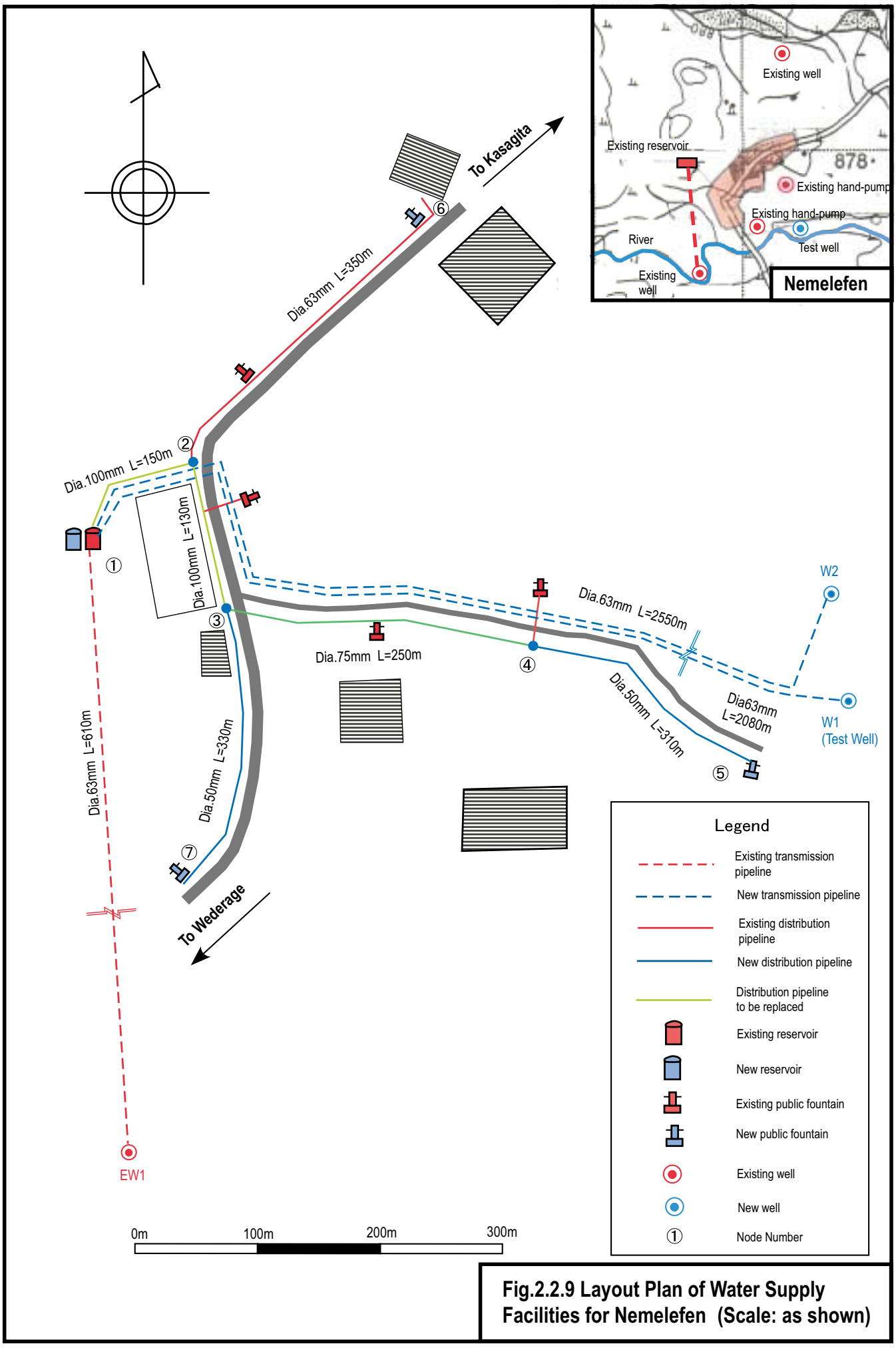


Fig.2.2.9 Layout Plan of Water Supply Facilities for Nemelefen (Scale: as shown)

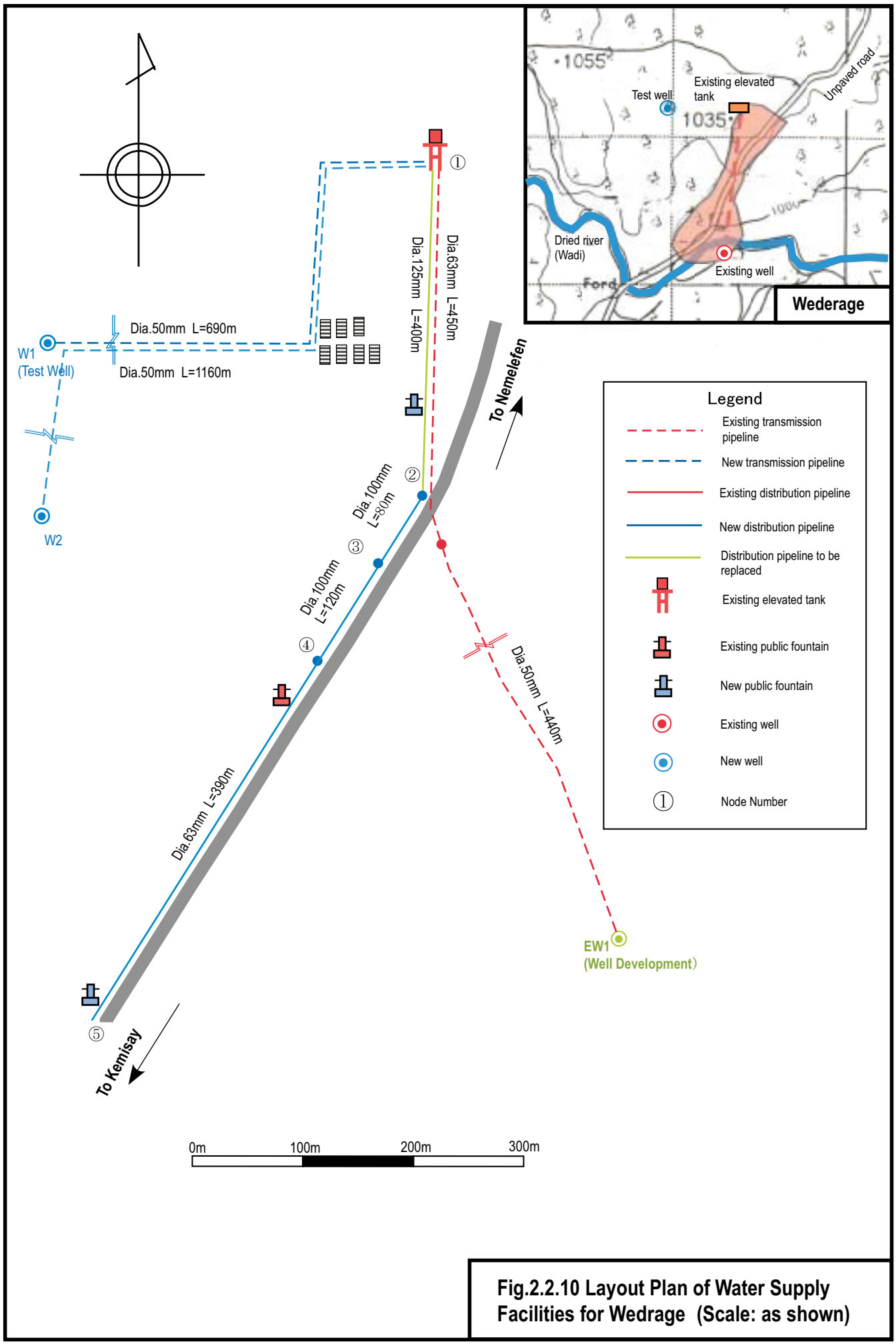


Fig.2.2.10 Layout Plan of Water Supply Facilities for Wedrage (Scale: as shown)

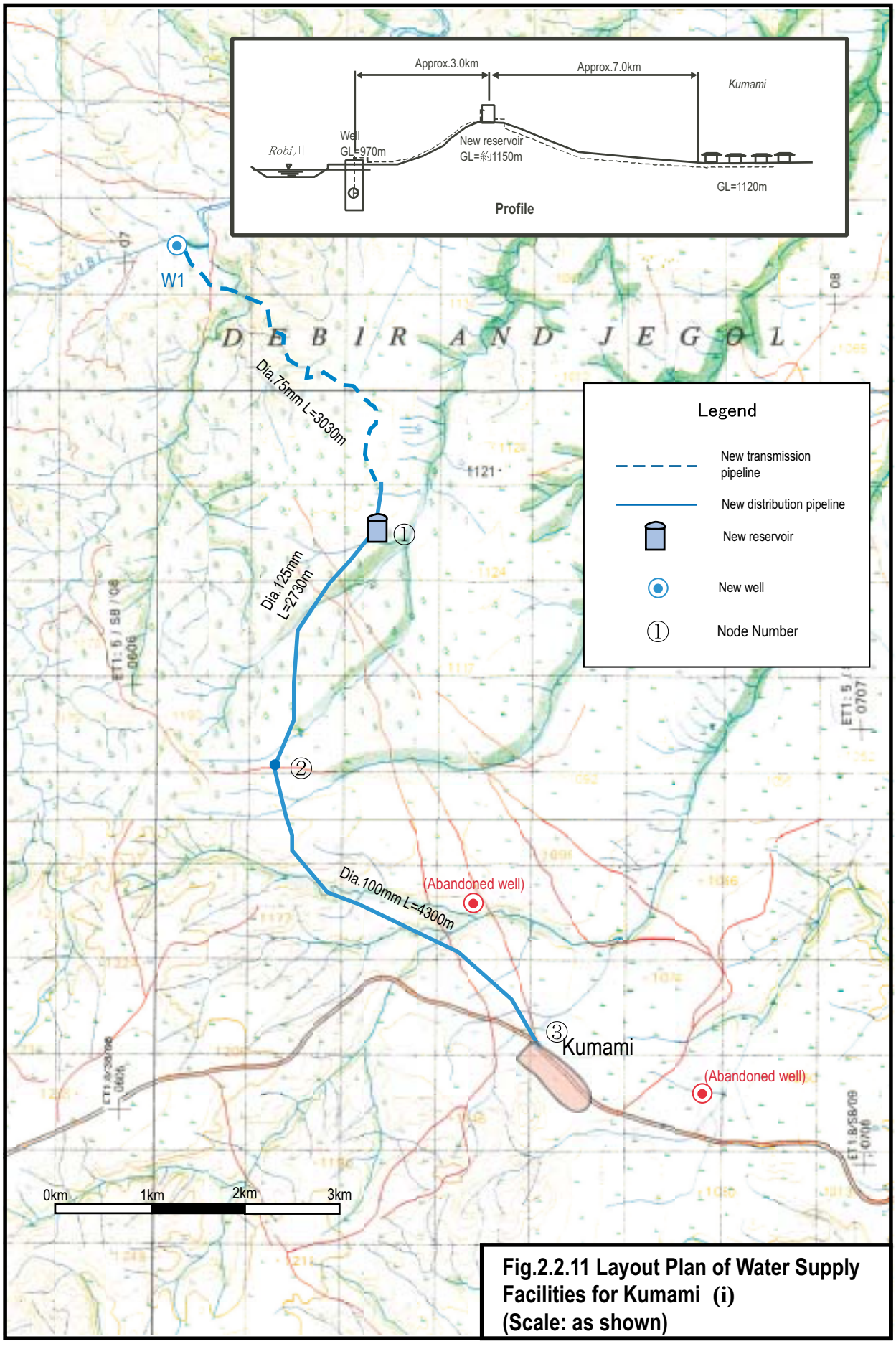


Fig.2.2.11 Layout Plan of Water Supply Facilities for Kumami (i) (Scale: as shown)

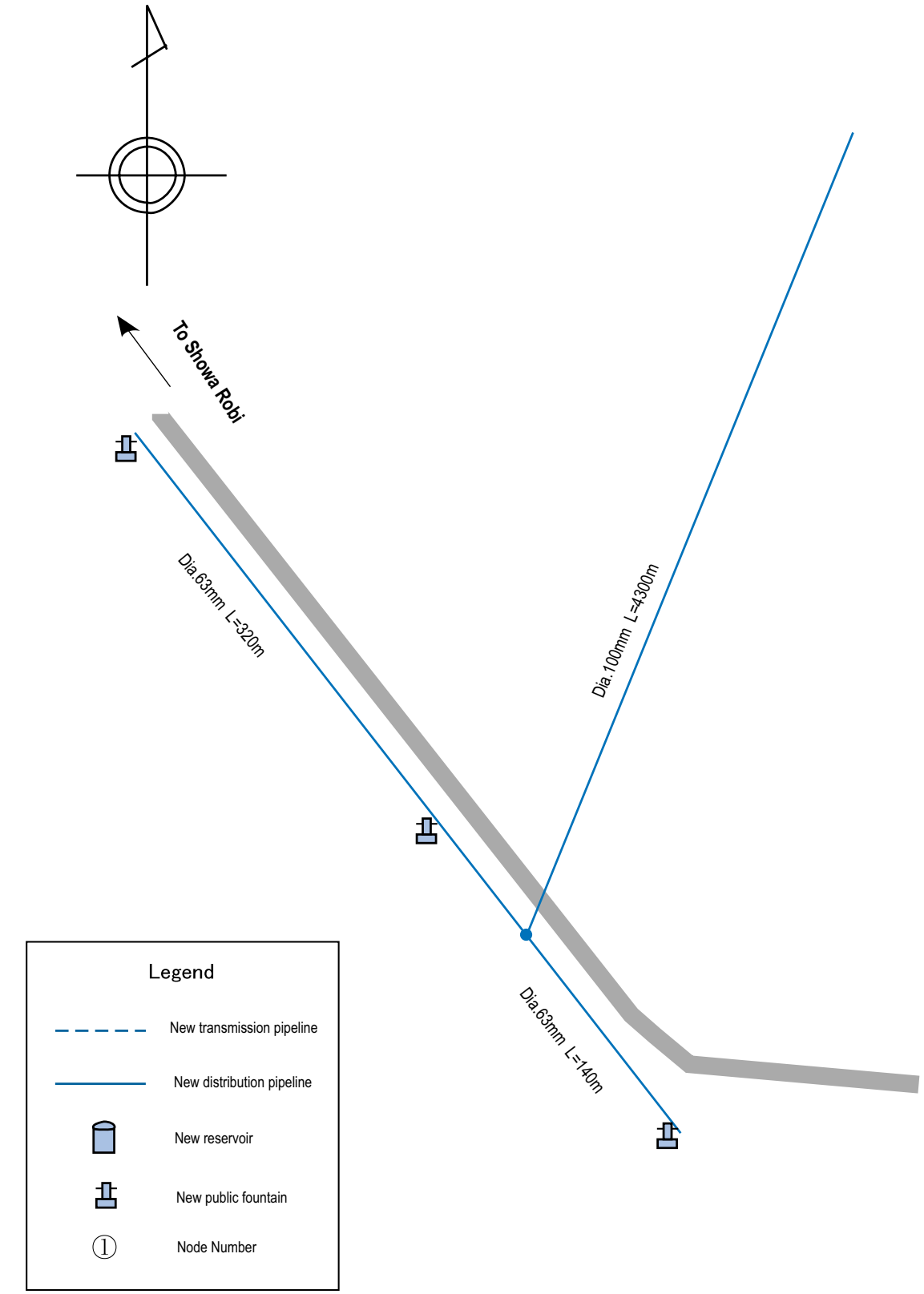


Fig.2.2.12 Layout Plan of Water Supply Facilities for Kumami (ii) (Scale: as shown)

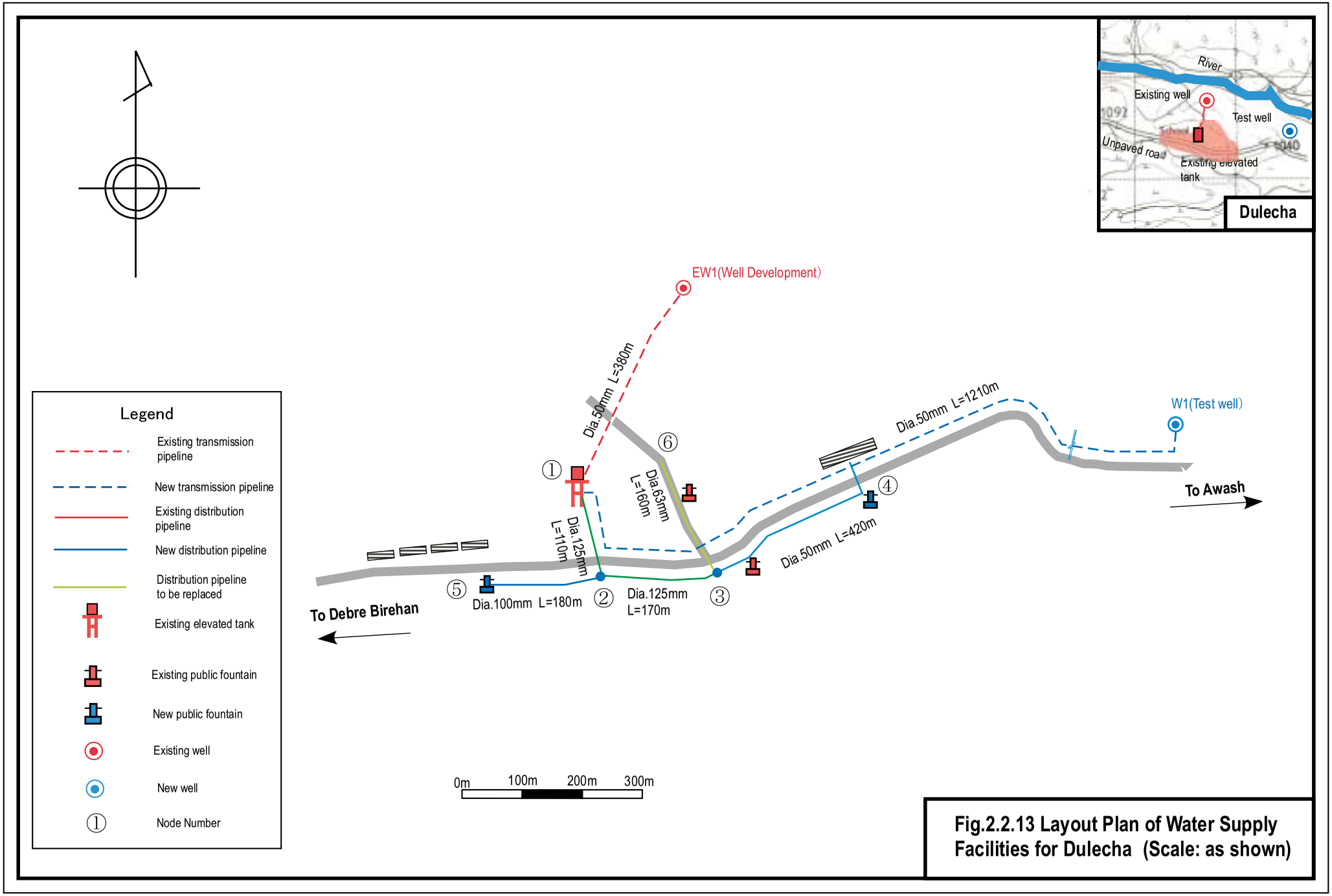
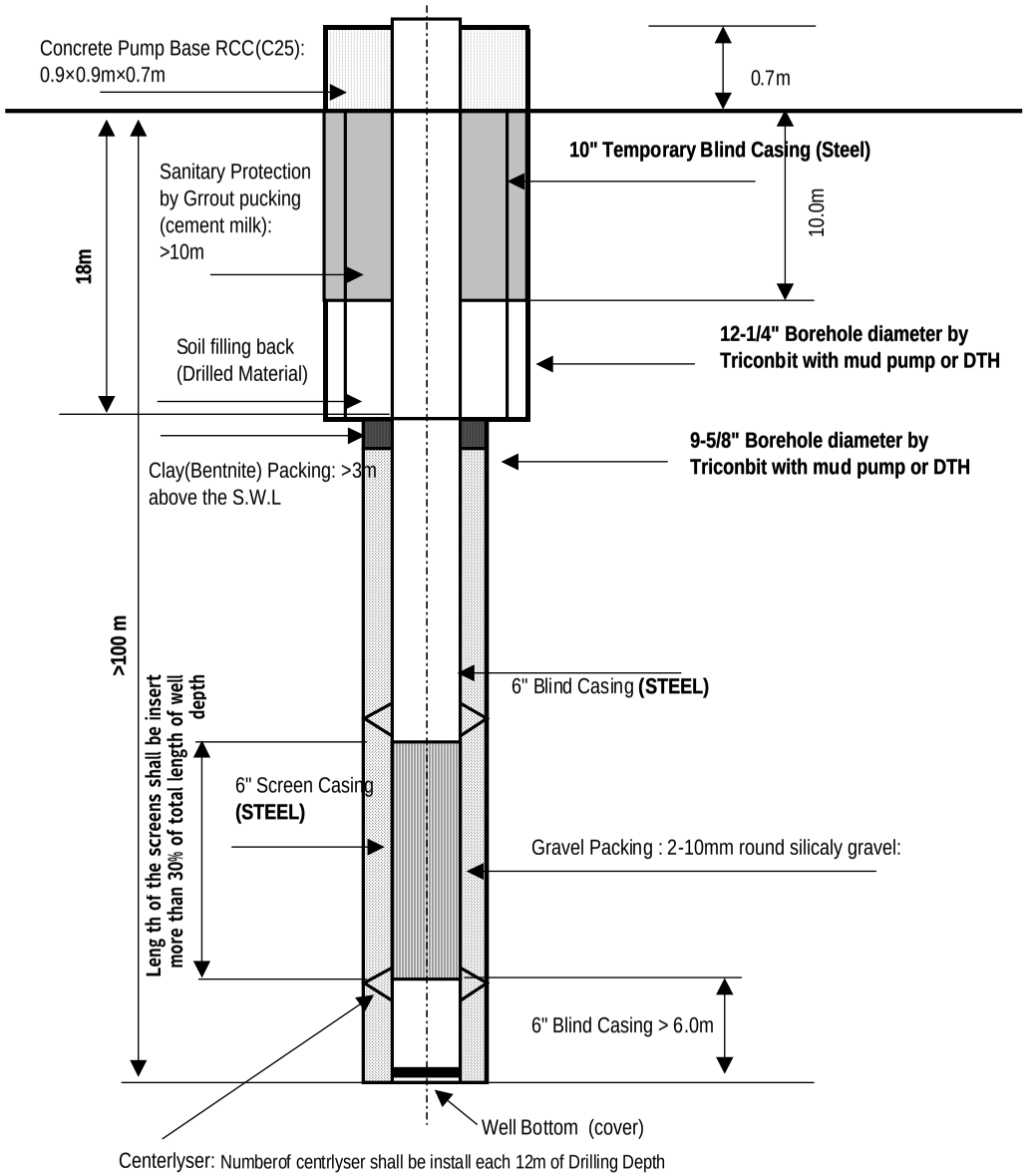
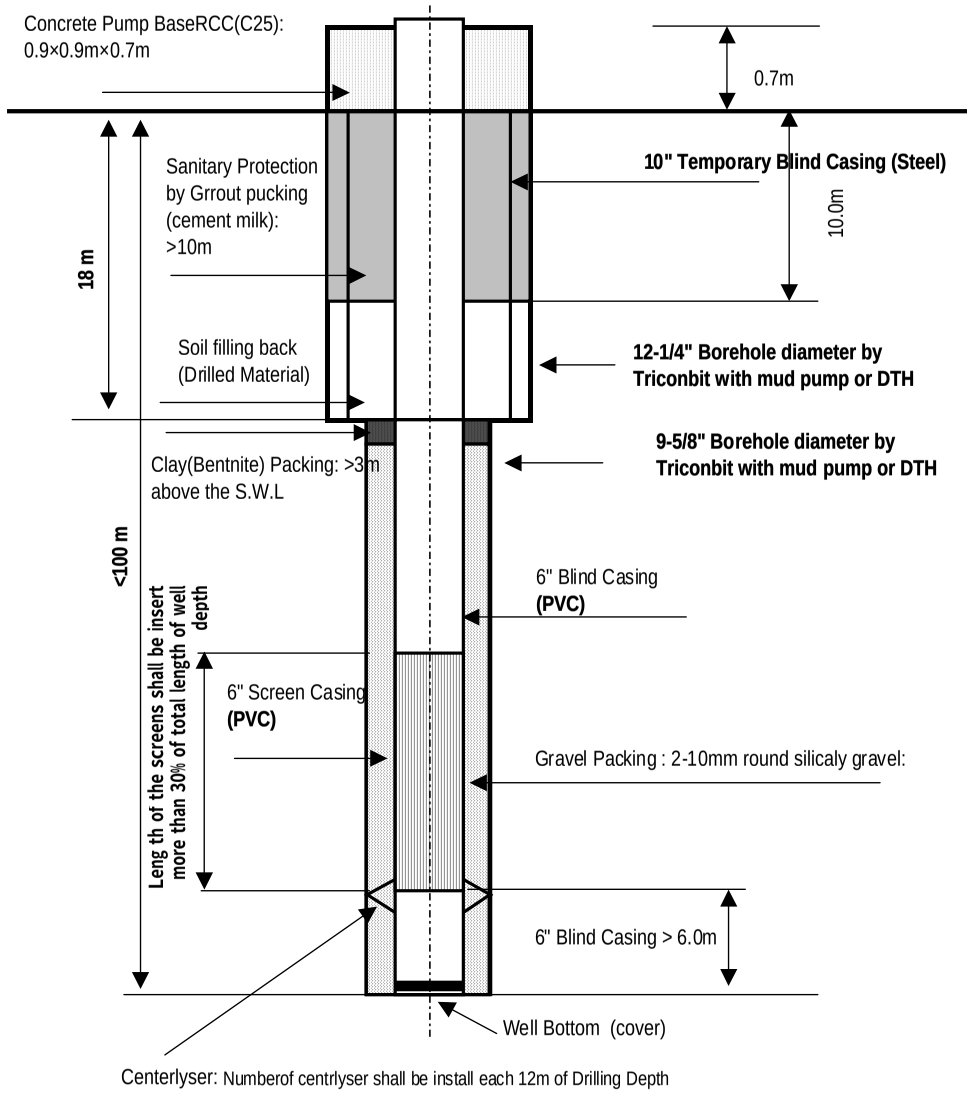


Fig.2.2.13 Layout Plan of Water Supply Facilities for Dulecha (Scale: as shown)

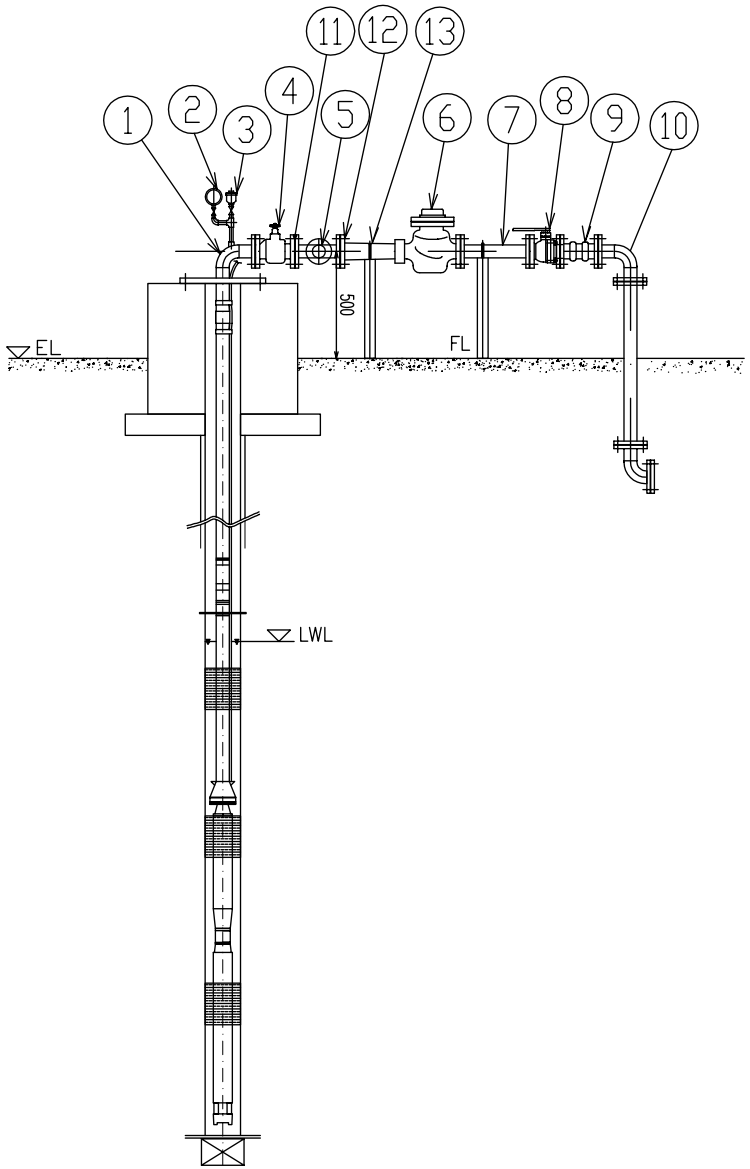
TYPICAL PROFILE OF PRODUCTION WELL (More than 100m Depth)



TYPICAL PROFILE OF PRODUCTION WELL (Less than 100m Depth)



KYOWA ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN	TITLE: Figure 2.2.5 Drawing of Typical Structure of Production Well			PROJECT: THE BASIC DESIGN STUDY ON THE PROJECT FOR WATER SUPPLY DEVELOPMENT IN THE AFAR NATIONAL REGIONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN		DATE: July 2006	NUMBER: 1/1	SCALE:



NO.	NAME OF PARTS	Q'TY	SPECIFICATION :Remarks
1	Well head	1	Steel DN65 screwed type
2	Compound gauge	1	3/8
3	Air vent valve	1	1/2
4	Check valve	1	DN65 PN10 flange FC :Water hammer prevention
5	Tees flanged	1	DN65 PN10
6	Water meter (Turbine type)	1	DN PN10 flange 5-20m3/h
7	Flanged pipe	2	DN65x400mm PN10
8	Gate valve	2	DN65 PN10 flange FC
9	Sleeve Joint	1	DN65 PN10
10	Elbow 90 degree flanged	2	DN65 PN10
11	Packing	10	DN65 PN10
12	Hexagonal bolt/nut set	10	DN65 PN10
13	Pipe stand	2	DN65 PN10

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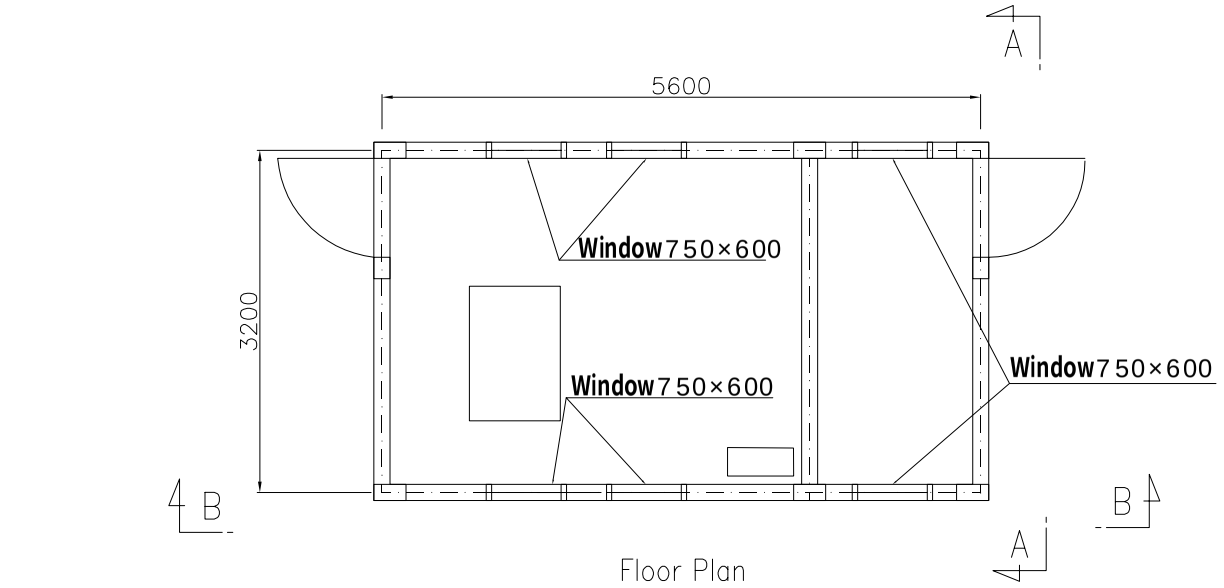
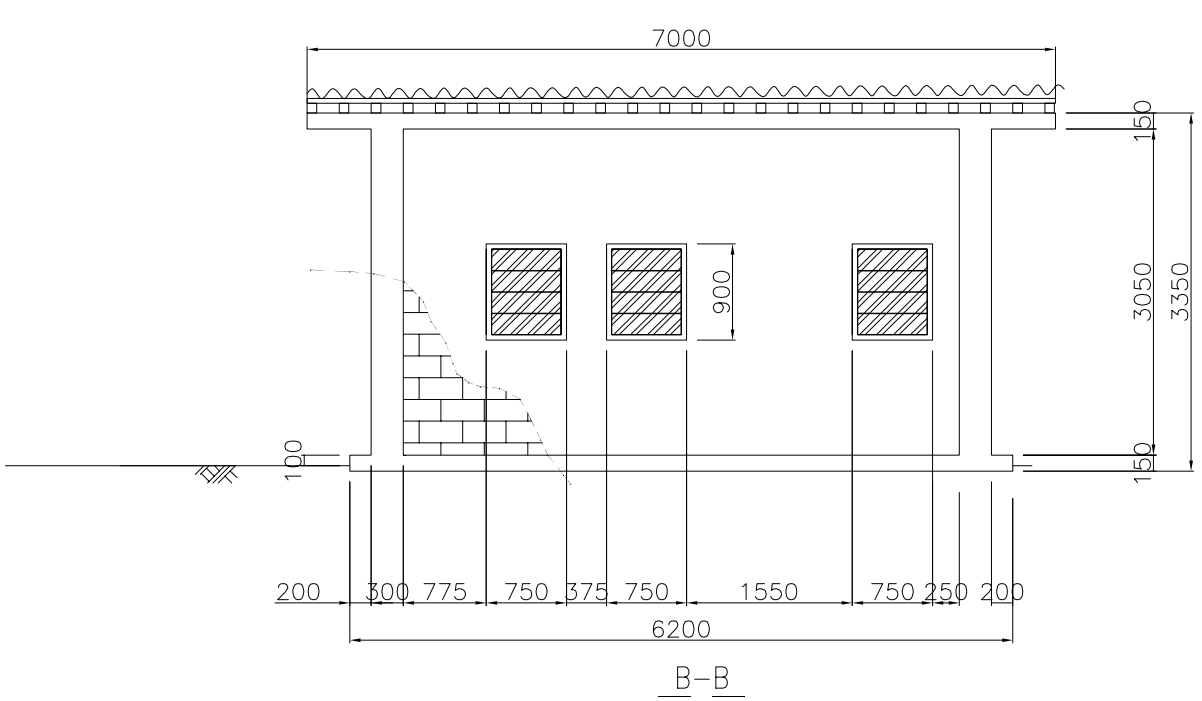
TOKYO, JAPAN

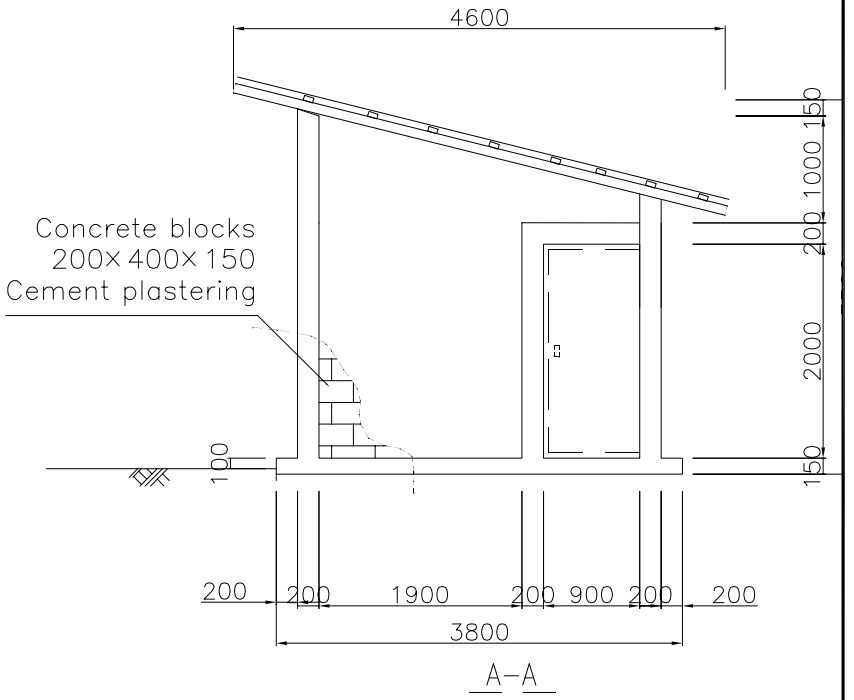
TITLE
Figure 2.2.6 Typical Pipe Arrangement Around Well

DATE: July 2006
NUMBER: 1/1
SCALE:

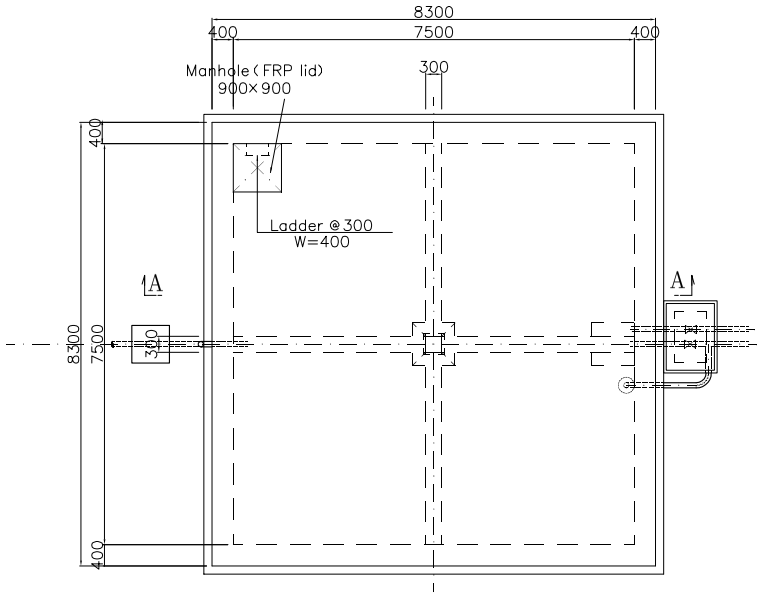
PROJECT
THE BASIC DESIGN STUDY ON THE PROJECT FOR WATER SUPPLY DEVELOPMENT IN THE AFAR NATIONAL REGIONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA



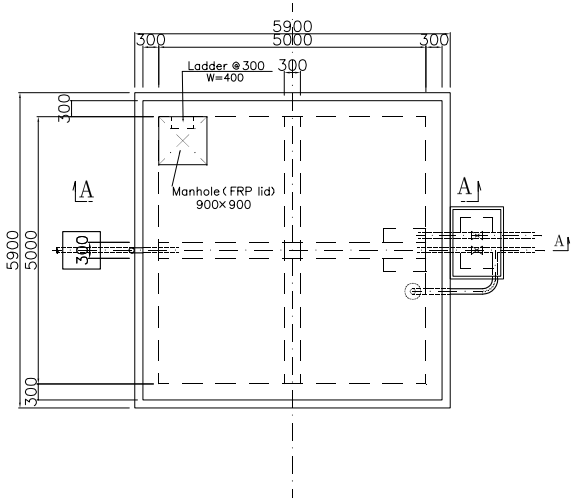




KYOWA ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN	TITLE: Figure 2.2.7 Structural Drawing of Generator House				PROJECT: THE BASIC DESIGN STUDY ON THE PROJECT FOR WATER SUPPLY DEVELOPMENT IN THE AFAR NATIONAL REGIONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN		DATE: July 2006	NUMBER: 1/1	SCALE:	

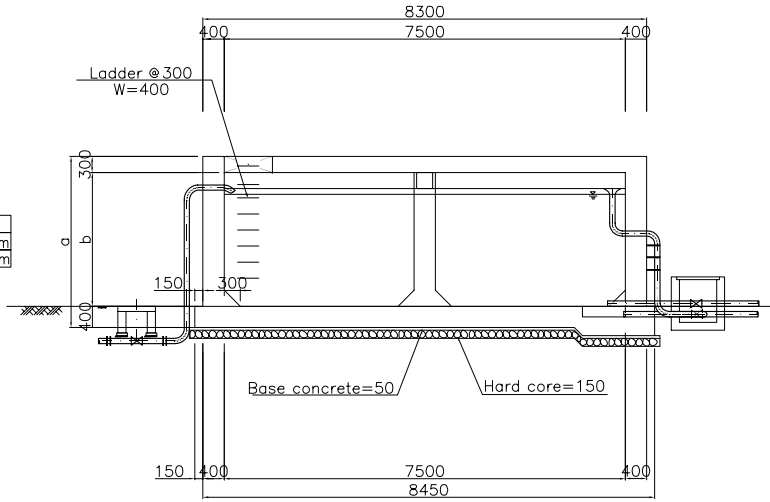


Floor Plan (V=130m3, 100m3)

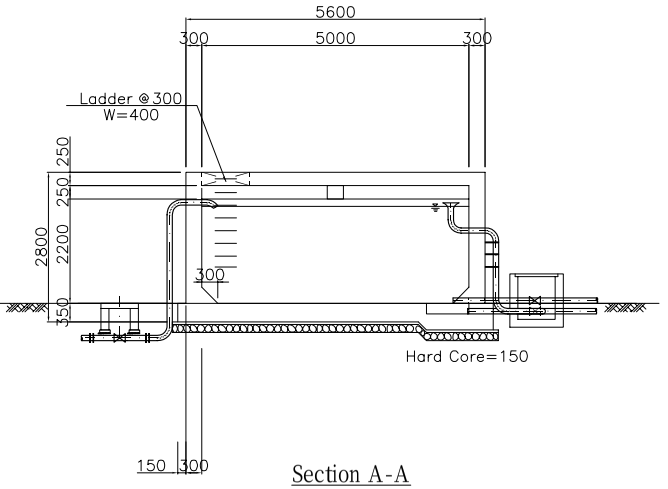


Floor Plan(V=50m3)

容量	a	b
100m3	2,700mm	2,000mm
130m3	3,200mm	2,500mm



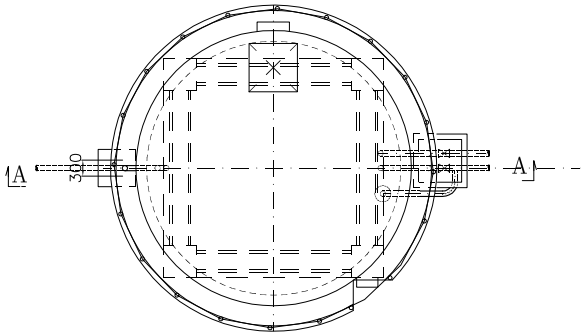
Section A-A



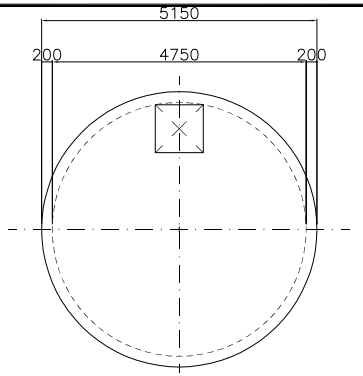
Section A-A

2-39

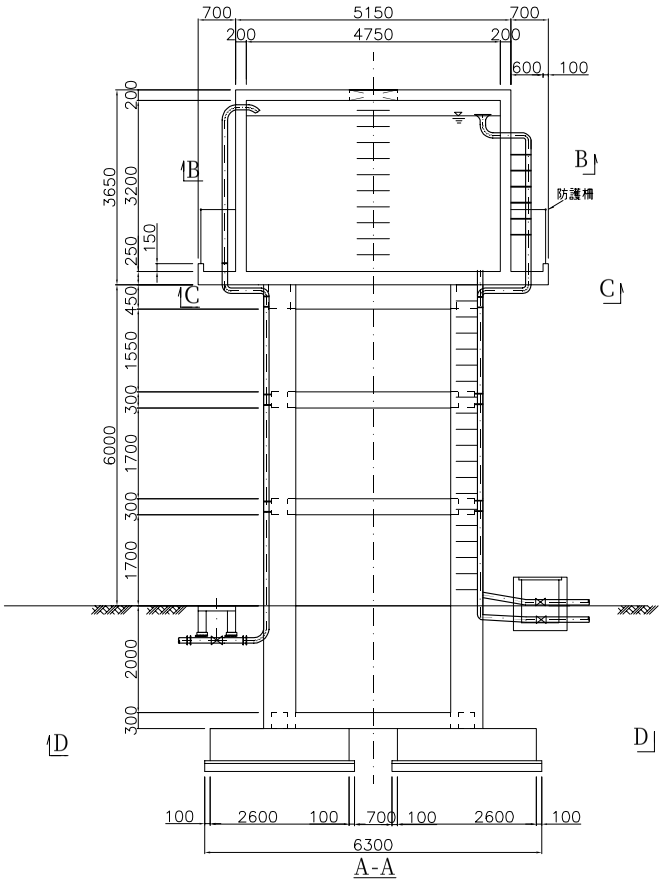
KYOWA ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN	TITLE: Figure 2.2.8.1 Structural Drawing of Service Reservoirs				PROJECT: THE BASIC DESIGN STUDY ON THE PROJECT FOR WATER SUPPLY DEVELOPMENT IN THE AFAR NATIONAL REGIONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN		DATE: July 2006	NUMBER: 1/1	SCALE:	



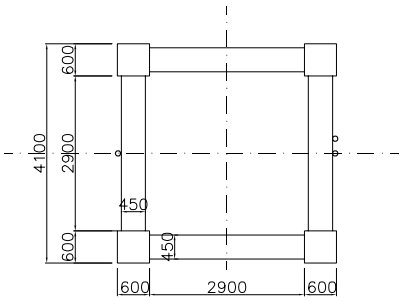
Floor Plan(V=50m3)



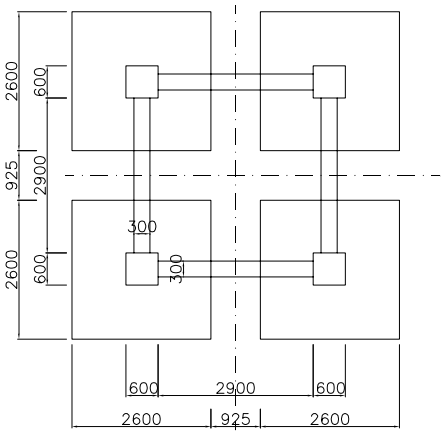
B-B



A-A

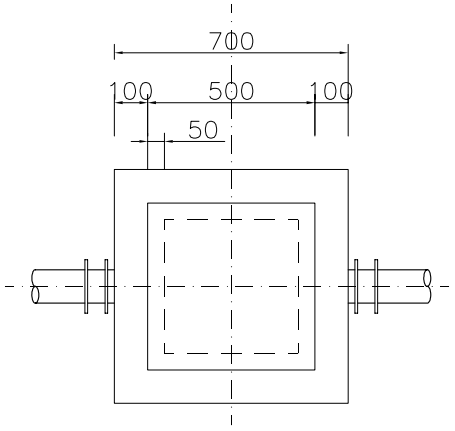


C-C

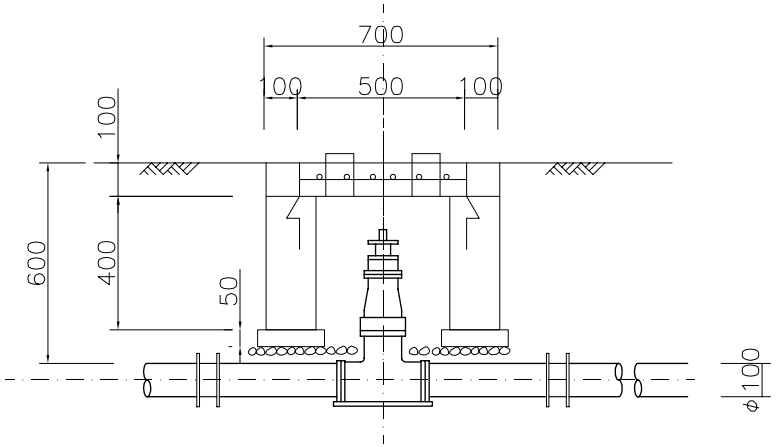


D-D

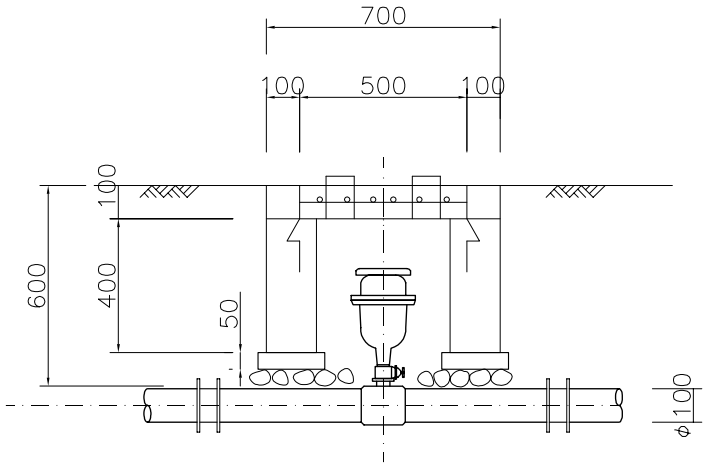
KYOWA ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN	TITLE: Figure 2.2.8.2 Structural Drawing of Elevated Tank				PROJECT: THE BASIC DESIGN STUDY ON THE PROJECT FOR WATER SUPPLY DEVELOPMENT IN THE AFAR NATIONAL REGIONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
YACHIYO ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN		DATE: July 2006	NUMBER: 1/1	SCALE:	



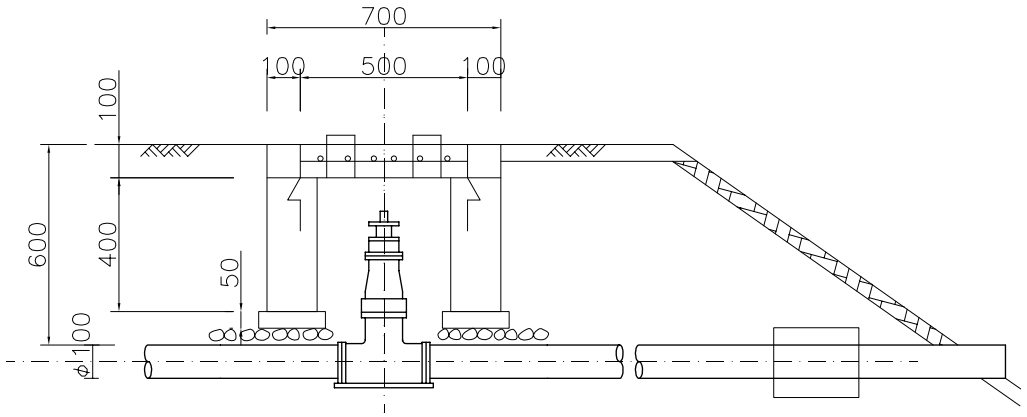
Floor Plan



Gate Valve Pit

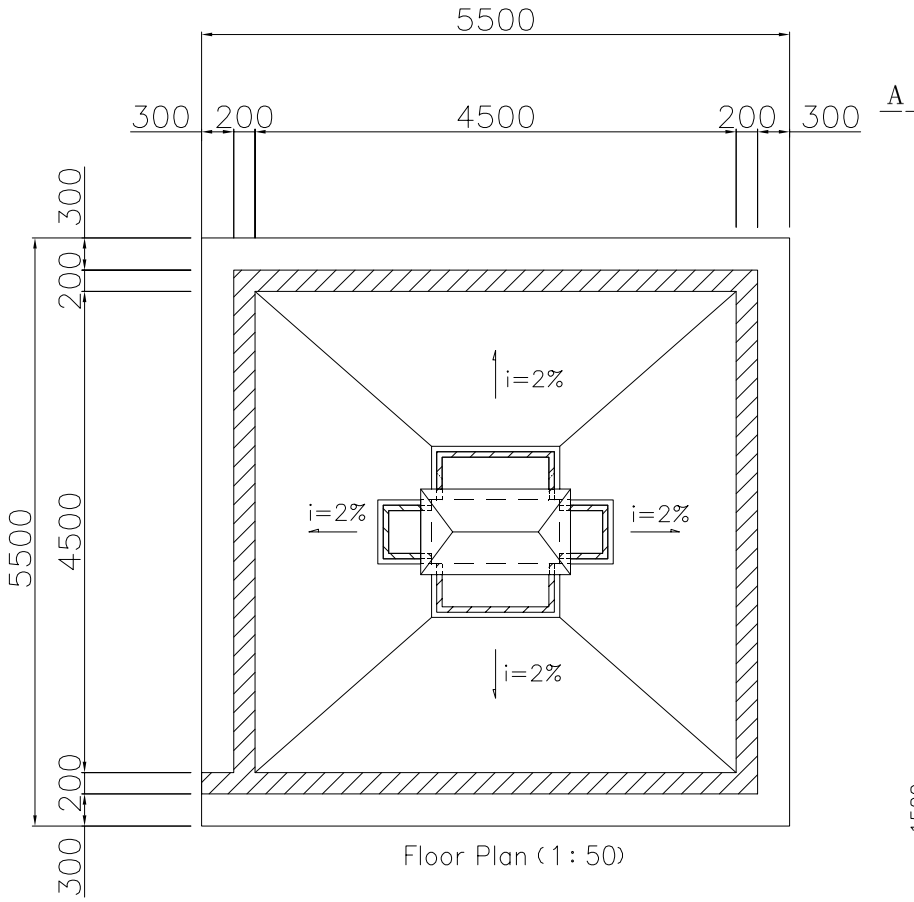


Air Valve Pit

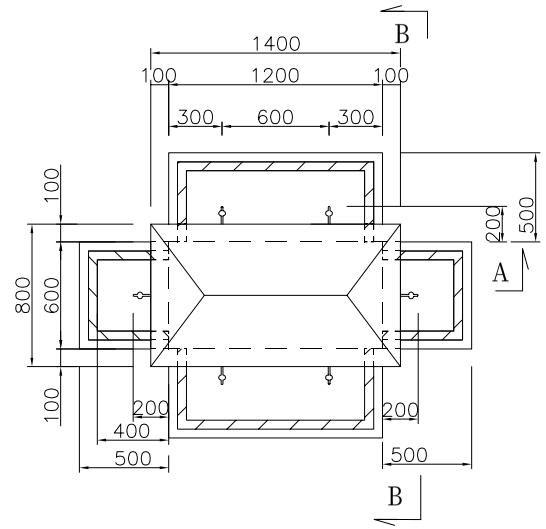


Drain Valve Pit

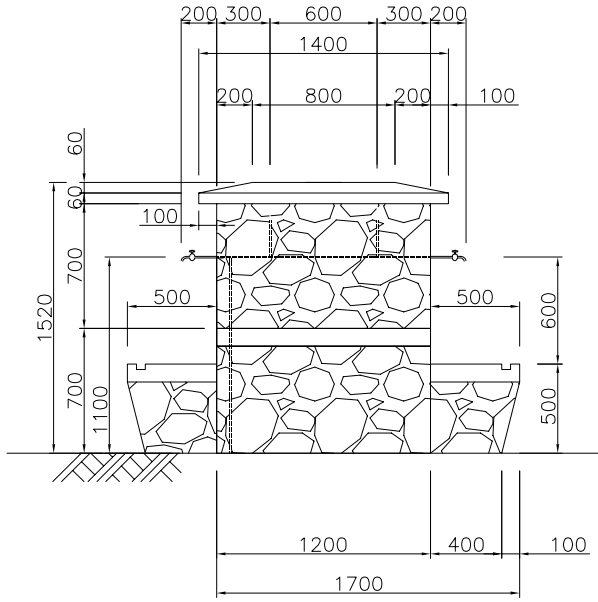
KYOWA ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN	TITLE: Figure 2.2.9 Drawing of Pipe laying and Chambers				PROJECT: THE BASIC DESIGN STUDY ON THE PROJECT FOR WATER SUPPLY DEVELOPMENT IN THE AFAR NATIONAL REGIONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN		DATE: July 2006	NUMBER: 1/1	SCALE:	



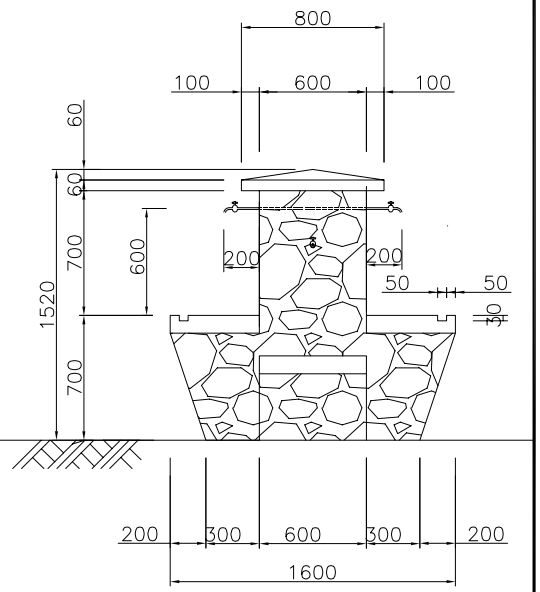
Floor Plan (1 : 50)



Floor Plan (1 : 30)

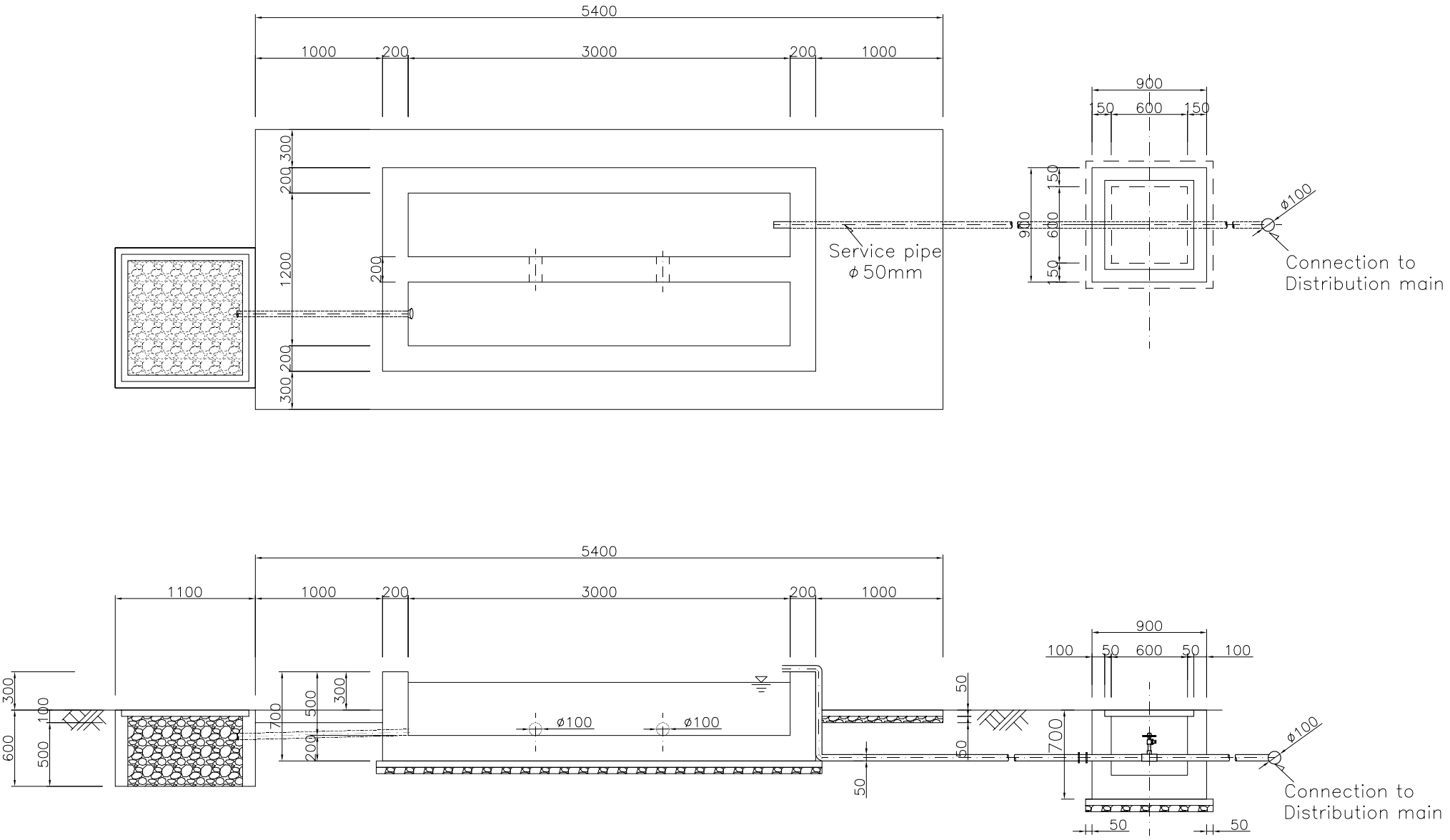


A-A



B-B

KYOWA ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN	TITLE Figure 2.2.10.1 Typical Structure of Public Tap				PROJECT THE BASIC DESIGN STUDY ON THE PROJECT FOR WATER SUPPLY DEVELOPMENT IN THE AFAR NATIONAL REGIONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN		DATE July 2006	NUMBER 1/1	SCALE	



KYOWA ENGINEERING CONSULTANTS CO., LTD. TOKYO, JAPAN	TITLE: Figure 2.2.10.2 Typical Structure of Trough for Livestock				PROJECT: THE BASIC DESIGN STUDY ON THE PROJECT FOR WATER SUPPLY DEVELOPMENT IN THE AFAR NATIONAL REGIONAL STATE IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA
YACHIYO ENGINEERING CO., LTD. TOKYO, JAPAN		DATE: July 2006	NUMBER: 1/1	SCALE:	

2-2-4 Implementation Plan /Procurement Plan

2-2-4-1 Implementation Plan

(1) Process and Structure of the Implementation of the Project

The work of the Project can be divided into two portions to be carried out by the governments of Japan and Ethiopia. The portion of the governments of Japan can be further divided into following three components:

1) Construction of the water supply facilities for 9 towns,
2) Procurement of the equipment for well rehabilitation work, and
3) Capacity buildings (Soft Component) in the well rehabilitation techniques and in managerial capabilities of water supply service in each target town.

The work to be done by the Ethiopian side is summarized in "Chapter 2-3" and will be carried out along with the work progress of the Japanese side.

Concerning the process of implementation of the Project, firstly the exchange of notes related to the implementation of the Project are signed between two governments of Ethiopia and Japan, and secondly the contract on consulting service is made between AWRB and a Japanese consultant. The consulting service is divided into two stages: 1) detailed design stage and 2) construction stage.

At the detailed design stage, the consulting service consists of 1) field survey, 2) detail design, 3) preparation of tender documents, and 4) assistance of tender work. At the construction stage, the consulting service consists of 1) supervision of the construction work to be performed by Japanese Contractor, 2) supervision of the construction work to be performed by the Ethiopian side, and 3) capacity building (Soft Component) for the well rehabilitation techniques and the managerial capabilities of water supply service.

The Contractor will be selected by the tender. The Contractor shall take actions for the procurement of construction materials after the conclusions of the contracts between the two parties, and the equipment for well rehabilitation will be ordered to manufacturers as well.

The Ethiopian side shall conclude banking arrangements after the conclusion of the exchange of notes, and take actions for total exemption of custom duties, internal taxes, etc. necessary for the delivery of the material and the equipment to be procured for the Project. In addition, it is necessary for AWRB to collaborate with Woreda Councils of the target towns and other related departments in Afar Regional Government for implementation of the Project.

Under this procedure and system of the all parties concerned, the formation of implementation of the Project is shown in Fig. 2.2.22.

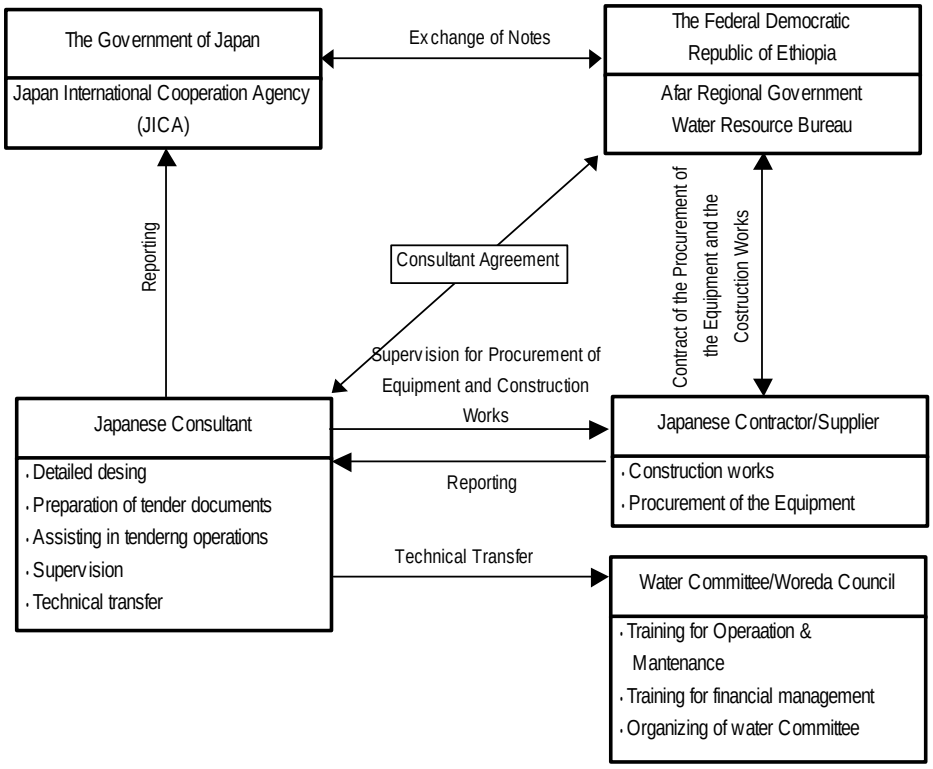


Fig.2.2.22 Formation of Implementation of the Project

(2) Concept of the Construction Work

The concept of the implementation of the construction work is as follows.

1) There are a lot of local construction companies, which are registered with the Ethiopian federal government and classified by the scale and years of business, with sufficient experiences of water supply project. Especially, the number of well drilling companies has increased recently. For these reasons, construction work including drilling work is basically subcontracted with Ethiopian contractors and carried out under the supervision of a Japanese Contractor.

2) The construction of water supply facilities will be executed at 9 towns in Afar Region. These 9 towns are located at 40km to 70km away from the national road and scattered each other in range from 16km to 60km distance. Considering this situation, it is necessary to carry out the construction works of two or three sites simultaneously in order to complete the construction works by the end of Japanese fiscal year.

3) The following staff of the Japanese Contractor is proposed to dispatch, considering co-working with local subcontractors.

   i) Representative of the Contractor

   One Representative is deployed and permanently stationed during construction of the Project. He is responsible for the overall performance of the construction work and shall always keep in touch with the contractor's staff, subcontractors, and the implementing agency in order to

grasp precisely the progress of the construction works.

ii) Civil Engineer

One civil engineer is deployed and permanently stationed as well as the representative. He assists the representative in his work and is in charge generally of the construction works except for drilling works.

iii) Drilling Expert

One drilling expert is deployed for the supervision of the drilling work to be performed by Ethiopian subcontractors.

iv) Electro-mechanic Expert

One electro-mechanic expert is deployed for the supervision of the installation work of machinery.

v) Administrator

One administrator is deployed for administrative and financial work, and he also keeps always in touch the implementing agency to make arrangements for smooth implementation of the Project.

(3) Concept of the Procurement of the Equipment

The concept of the procurement of the materials and the equipment for the construction works is as follows.

1) Pipe materials, submersible motor pumps, generators, etc. will be procured in the Ethiopian market.

2) Concerning the equipments unavailable in the local market, Japanese product or third countries' product shall be procured, based on the examination of the cost comparison, the delivery schedule, the availability of the spare parts and so on.

3) The technical requirement of the equipment shall be in conformity to the European standard or internationally authorized standards.

4) The equipment for well rehabilitation will be Japanese products or third countries' products because of unavailability in the local market. Quality guarantee, service, availability of spareparts and consumables, delivery schedule, etc. shall be taken into consideration for the procurement.

5) The delivery schedule of the equipment and the materials shall be well arranged in order to avoid delay of the construction schedule.

2-2-4-2 Implementation Condition

(1) Considerations for Construction Works

Considerations for construction works to supplement the concept of construction works are as follows.

1) Setting up of the Back-up System in AWRB

Before the commencement of the construction, the details of the Project shall be well informed to the Woreda Councils and Water Committees of the target towns. In addition, it is necessary for AWRB to reinforce back-up system for assisting Woreda Councils and Water Committees in overall managing activities of water supply.

2) Climate Condition

Generally, there are two rainy seasons in a year in Project site: 1) Small rainy season from February to April and 2) Big rainy season from July to September. The drilling work of test wells done in the Basic Design Study was far behind the schedule due to continuous rain from late March to early April 2006. Most of access roads from main roads to the project sites are gravel road, and most of town-to-town roads are trail road that is crossing wadis. During the period of rainy season, it is often difficult to mobilize from site to site because of muddy roads and running rivers. Therefore the construction schedule shall be planned with carefully consideration of above risks.

3) Safety Control

It is necessary to keep inhabitants off the construction site, in order to secure the construction works from any accidents. Especially for the drilling works, the protective fence shall be installed, and the watchman shall be stationed as well.

4) Consideration of Religion

It is necessary to draw up a construction schedule in consideration of religious events and activities, because the majority of inhabitants are Muslims in the project sites.

5) Location

The project sites are about 600km away from Addis Ababa. The construction materials and equipment to be imported from overseas are delivered from the port of Djibouti, and then transferred to the project site. Considering the geographical characteristics of the project site, a base camp and a stockyard for the construction will be established at the town in Afar Region where has an advantage of accessibility to the every target town.

(2) For the Procurement of the Equipment

The following points shall be paid attention to implement a smooth procurement of the equipment and materials.

1) To grasp progress of manufacturing and quality control.
2) To keep punctual transportation of the equipment and materials.
3) To ensure prompt unloading at port of disembarkation and smooth custom clearances.
4) To secure transportation of the equipment from traffic accidents.

2-2-4-3 Scope of Works

The scope of works for each country is as follows.

Table 2.2.14 Apportionment of Operation

Japanese side	Ethiopian side
• Construction of water supply facilities for 9 towns • Procurement of the equipment for the rehabilitation of existing wells • Capacity building on well rehabilitation techniques and managerial capability of water supply service	• Construction of access road for the well drilling • To secure the land necessary for water supply facilities • Installation of protective fences • To secure the technical personnel who will be trainee • To secure necessary garage for the equipment and keep in good condition • To carry out well rehabilitation project by his resources • To educate water users on water using manners or hygienic issues • To assist in the creation of water committee • To coordinate the works to be done by Woreda Council、water committee, and related agencies • To take prompt actions for the procedures of import, tax exemption, etc. • To secure workshops and mechanics to care the equipment to be procured in the Project

2-2-4-4 Consultant's Supervision

(1) Plan of Construction Supervision

1) Points to Notice for Construction Supervision

The Consultant shall pay attention to the following points for the construction supervision:

- Details of the Exchange of Notes concluded by and between the governments of Ethiopia and Japan,
- Details of the work to be carried out by Ethiopian,
- Procedures of customs clearance for the imported equipment and tax exemption for the products and services procured in Ethiopia,
- Progress and quality of construction work, and
- Cultural and religious background at the project sites and the inhabitants' consent for the Project.

2) Scope of Works of Consultant

The scope of works of Consultant is summarized as follows:

【Detailed Design Stage】

i) Field Survey

- To grasp climate condition, topographic and geological condition, availability of construction materials, equipment, and labor, construction method, etc. necessary for the detailed design.
- To confirm whether budgetary measures are arranged for the works to be done by the Ethiopian side.
- To confirm the status of the test wells constructed in the Basic Design Study.
- To carry out additional hydrogeological survey for selection of well sites to be newly drilled in the Project.
- To carry out additional topographic survey for pipeline routes from the newly selected well sites and to the proposed reservoirs.
- To form consensus on the locations of proposed wells, reservoirs, pipeline route, and public taps with Woreda Council and Water Committee in every project sites.

ii) Detailed Design

- To prepare detailed drawings.
- To re-estimate the project cost in accordance with some changes to be brought on the detailed design stage.
- To draw up the implementation plan.
- To finalize technical specifications and bill of quantities and re-draw up the schedule of equipment procurement.

iii) Tendering

- To prepare a set of tender document.
- To announce the prequalification notice and evaluate the documents to be submitted by companies interested in participation of the Project.
- To assist tendering operations, tender evaluation, and contract between the implementing agency and the Contractor.

【Construction Stage】

- To report the progress of the construction to the implementing agency.
- To supervise the construction works performed by Japanese Contractor.
- To carry out capacity buildings (Soft Component) for well rehabilitation technique and managerial capability of water supply service.
- To examine technical specification of the equipment offered by the Contractor, inspect manufacturing, examine shipping document, and inspect it before the shipping.

- To inspect the equipment on site before delivery to AWRB.

【Post Inspection after a year from the completion of construction works】

- To inspect defects of the facilities and equipment, and give the instructions on the measure against such defects to the Contractor.
- To advice the corrective measure on Water committee's activities to AWRB.
- To report results of inspection to JICA.

3) Staffing

The staff of the Consultant for the execution of the works is as follows:

【Detailed Design Stage】

- Project Manager
  Project manager will control the progress of the detailed design and expedite the works to be undertaken by the Ethiopian side.
- Water Supply Engineer
  Water supply engineer will design water supply facilities and prepare design drawings.
- Hydrogeologist
  Hydrogeologist will grasp hydrogeological characteristics of the project sites, select the drilling sites and design well structure of new wells.
- Cost Estimator
  Cost estimator will re-estimate the project cost.
- Specification Writer
  Specification writer will prepare the tender document that covers from tender instructions to technical specifications of the construction works and the equipment.

【Construction Stage】

- Project Manager
  Project manager will supervise comprehensive activities of the project and water supply facilities on the basis of part time assignment schedule for construction period.
- Civil Engineer
  Civil engineer will supervise the construction works on the basis of full assignment schedule for the construction period.
- Hydrogeologist
  Hydrogeologist will supervise well drilling works on the basis of part time assignment schedule for the construction period.
- Electromechanic Expert

Electromechanic expert will supervise the installation work of the machinery on the basis of part time assignment schedule for the construction period.

【Post Inspection after a year from the completion of the construction works】

- Project Manager
  Project manager will inspect the facilities, grasp and evaluate the status of water supply management, recommend or suggest AWRB and the parties concerned for sustainable O&M of the water supply facilities.

2-2-4-5 Procurement Plan

The equipment will be procured basically in the local market from the aspects of economical project cost and availability of the spareparts. As for equipment unavailable in the local market, they will be procured from Japanese or the third counties' market. The country origins of manufacturing of the equipment are summarized as shown in Table 2.2.15.

Table 2.2.15 Country Origins of Equipment and Construction Materials

Equipment and Construction materials	Japan	Ethiopia	Third country
Well casings and screen pipes		◎	
Submersible motor pumps including pumping test use			◎
Diesel generators including pumping test use			◎
Pipe materials		◎	
Valves			◎
Trucks with crane for well rehabilitation works	◎		
Equipment for the pumping test such as water level detector, portable water quality analysis kit, etc	◎		◎

2-2-4-6 Quality Control Plan

(1) Construction

Quality control on construction materials and construction works will be carried out, based on the quality control program. Its inspection frequency and method are based on Japan Industrial Standard (JIS), construction standards, etc.

⑵ Equipment

The quality control of the equipment is carried out as follows:

i) Checking up the offered technical specification and shop drawings submitted by the Contractor and/or Manufacturer with the technical requirement,

ii) Quantitative inspection before shipment of equipments, and

iii) Operational fault check at the initial operation.

2-2-4-7 Implementation Schedule

The implementation plan of the Project is as shown in Fig. 2.2.23. After the conclusion of the Exchange of Notes between two countries of Ethiopia and Japan for the implementation of the Project, the periods of the Detailed Design, the Procurement of the Equipment and the Construction of Water Supply Facilities for 9 towns are estimated at 8 months, 4 months and 15.5 months respectively. Concerning the soft component, it takes 4.2 months to carry out.

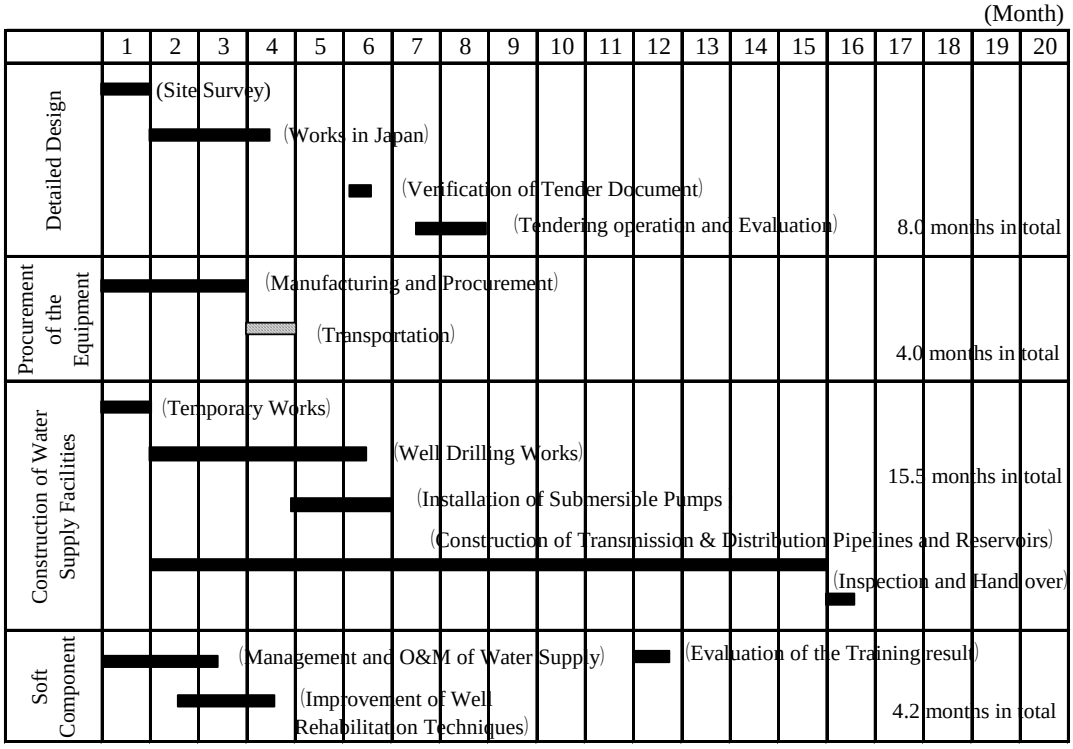


Fig. 2.2.23 Implementation Plan

2-3 Obligations of Recipient Country

The Project is basically composed of three components: 1) the construction of water supply facilities for 9 towns, 2) the procurement of the equipment for the well rehabilitation, and 3) the capacity building of human resource (Soft Component). In order to conduct above-mentioned components smoothly, the obligations to be undertaken by Ethiopian side are as shown in Table 2.3.1. Ethiopian side shall take actions for each obligation along with the implementation schedule.

Table 2.3.1 Obligations to be Carried out by Ethiopian Side

Obligations	
1. General	• To pay bank commissions for the services of Japanese foreign exchange bank, based on the banking arrangement, • To ensure prompt unloading at the port of disembarkation, and custom clearance for the equipment and materials purchased under the Project, • To exempt all the products procured for the Project from the custom duties, internal tax, value-added tax, etc., • To exempt Japanese nationals from the custom duties, internal tax, value-added tax, etc. in relation to the goods or the services under the terms of the Contract, • To secure the safety of the activities for the implementation of the Project,
2. Construction works of water supply facilities for 9 towns	• To appoint counterparts staff for the Project implementation, • To take actions for procedural authorization necessary for the construction work, • To finalize land acquisition and site clearance, • To construct access road, which will be used as the maintenance road, to the well drilling site from Kumami town, • To install the protective fences for the wells and the public fountains proposed in the Project, • To have consent on implementation of the Project from the administrative authorities and inhabitants of each target town,
3. Technical transfer of the well rehabilitation techniques	• To appoint the trainees from the personnel in AWRB, • To bear all the expenses necessary for the on-site training, such as perdiem and lodging fees for the trainees, • To provide the lecture space, desks, chairs, etc. necessary for the off-site training, • To bear fuel and consumable cost for the vehicles and machinery in order to carry out the on-site and off-site trainings, • To reinforce backup system for assisting Woreda Council and Water Committee,
4. Technical transfer of water supply management	• To have consent on formulation or empowerment of the Water Committees from the concerned parties, • To carry out activities of hygienic education to the water users, • To assist the Water Committees in the activities of water supply management,

2-4 Project Operation Plan

2-4-1 Structure Necessary for Overall Management of the Project

AWRB, WSO (Ex-Water Desk) at Woreda level, and Water Committees participate in overall management of water supply schemes proposed in this Project, as shown in Fig. 2.4.1.

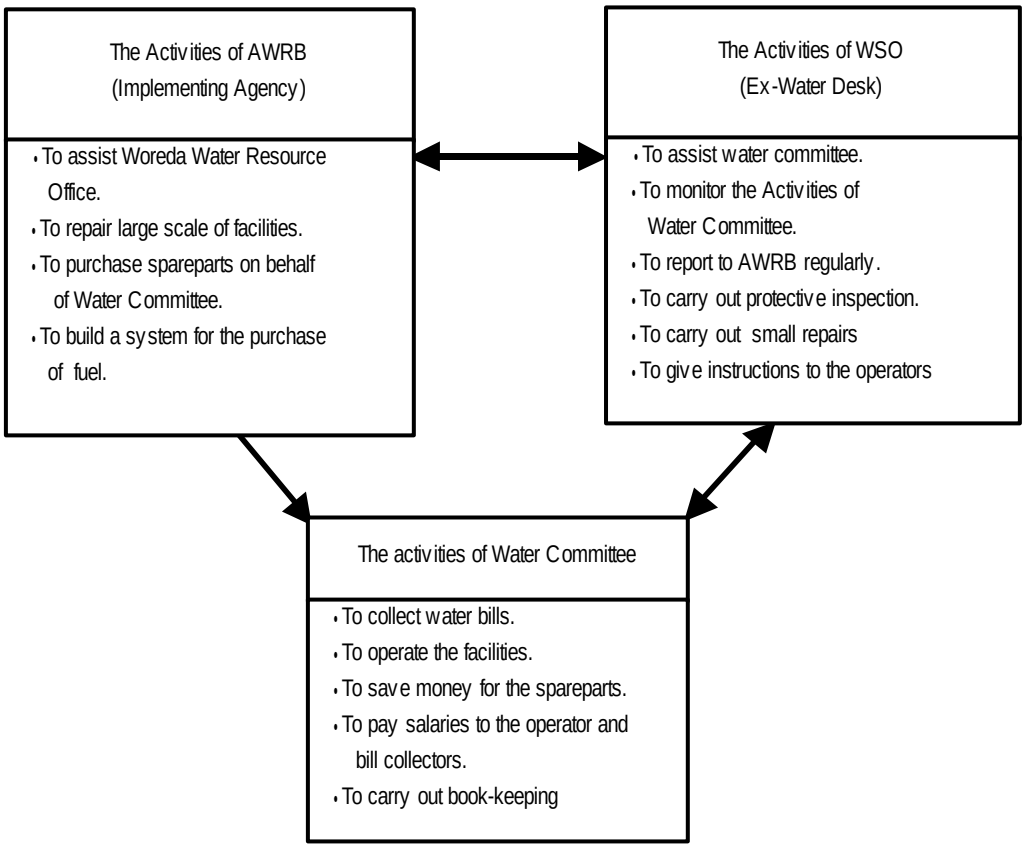


Fig. 2.4.1 Overall Structure of Water Supply Management

AWRB assists Water Committee's activities through WSO, and WSO carries out the work beyond the capability of Water Committees. The respective roles and the activities are summarized as follows.

2-4-2 AWRB (Implementing Agency)

AWRB is under direct control of the State President as shown in Fig. 2.4.2 and consists of three departments: 1) Study & Design Department, 2) Water Resource & Contract Administration Department and 3) O&M Department[1]. Furthermore, Study & Design Department consists of Study Team, Design & Study team and Water Resource & Contract. Administration Department consists of Contract Administration Team, Water Resources Administration & Policy Study Team and Water Quality Control Team.

[1]) O&M Department is supposed to formulate newly by a resolution of the State Congress in April 2006.

AWRB has been requested very often to repair and maintain the malfunctioned water supply facilities from Water Desks or Woreda Councils in the State. However, it was too difficult to take prompt actions for such requests because of insufficient human and financial resources. Considering this situation, the reorganization of AWRB was planned and has been in process.

Before the reorganization, there were 28 personnel in the bureau, and about 100 aid staffs are deployed to support the 28 personnel from the pool section of the Regional State Government. Under the new organization, number of the staff of AWRB will be reinforced up to 87 persons in total. However, in order to conduct better O&M activities, AWRB does not have any trainings program on capacity buildings for the staff. Therefore capacity building of the AWRB's staff is one of the most important policies that AWRB holds up.

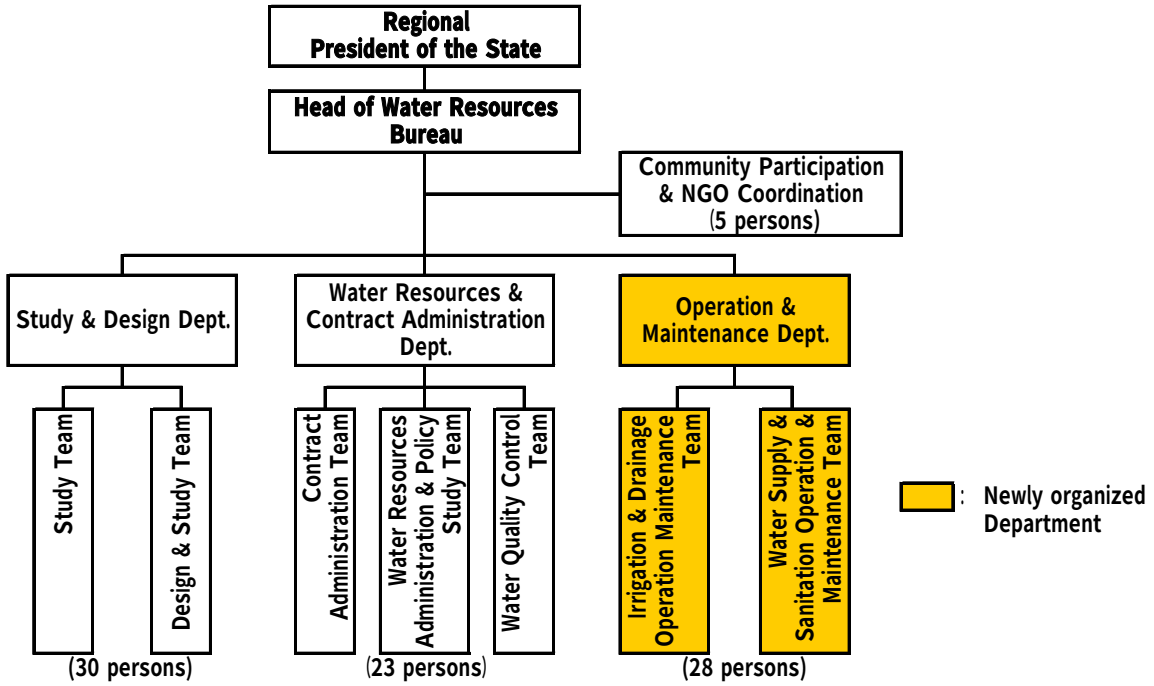


Fig. 2.4.2 New Organizational Set-up of AWRB

In addition to above, instead of Ex-Water Desk, WSO will be newly formed at Woreda level. AWRB is aiming to appoint graduates from Technical Vocational Education Training Center[1)] to the staff of WSO. Since 2003, AWRB has sent students to the Centers located in Afar, Amhara and Tigray States, along with the training program formulated by MoWR. Currently 21 students are under training, and 7 students are expected to complete all the training courses of this program as the first graduates and to join AWRB in 2006. By this arrangement, AWRB also intends to establish a close administrative relation between

[2 1)] The Ministry of Water Resources, in collaboration with UNDP, made a training program in order to increase skilled personnel in the field of Sanitation, Irrigation, and Electro-mechanics. The program with 3 years curriculum has been in operation at 9 schools (boarding school) since 2003 in the country. In case of Afar State, a school was opened at Luci in 2004, and about 200 students will first graduate in 2007.

Woredas and itself.

2-4-3 WSO

WSO will be newly formed at Woreda level instead of Ex-Water Desk and under the control of AWRB. Annual budget will be allocated to WSO to carry out their responsibilities. WSO will be responsible for the protective inspection of the facilities and assisting all the activities of Water Committee. In case of simple mechanical breakdowns of the facilities, the staff of WSO repairs them and also give the instructions to the operator, if necessary. Furthermore, WSO reports activities of protective inspection to AWRB regularly, and requests AWRB to dispatch O&M crew for coping with heavy mechanical breakdowns.

In addition, WSO will also assist Water Committee and water users to solve problems in water supply management. For the towns without Water Committee, WSO is responsible for organizing Water Committee. In this Project, capacity building on managerial trainings for water supply service is planned to conduct for Water Committee, WSO and staff of AWRB in order to ensure sustainable water supply management.

2-4-4 Water Committee

In Ethiopia, Water Committee basically handles the management of small-scale water supply with assistances of AWRB and Water Desk. A typical organizational set-up of Water Committee is as shown in Fig. 2.4.3.

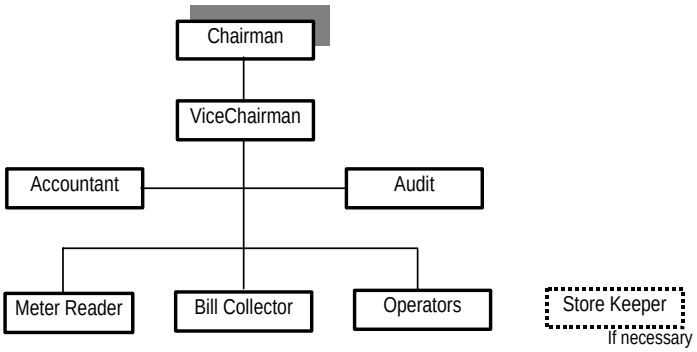


Fig. 2.4.3 Typical Organizational Set-up of Water Committee

As the results of the socio-economic survey done in this Basic Design Study, the inhabitants do not generally satisfied with the activities of the present Water Committee in the target towns. Major dissatisfactions pointed out by the inhabitants are as follows:

1) Unstable water supply hours,

2) Inadequate transparency of accounting management,
3) Insufficient skill of O&M for water supply facilities, and
4) Non-fulfillment of an agreement of Water Committee.

It was assumed that Above-mentioned dissatisfactions might be caused by managerial difficulties such as water source difficulties (quantity and quality), mechanical problems, etc. of the Water Committees. And it was judged that AWRB and Water Desks had insufficient capability in the water supply management.

By the implementation of the Project, the sound working water supply system will be set up for fulfilling user's requirement. In addition to the construction of water supply facilities, capacity building for the enhancement of managerial skill of Water Committee will be conducted in collaboration with WSO and AWRB during the project implementation.

2-5 Project Cost Estimate

2-5-1 Cost Estimate for Construction and Procurement of Equipment

(1) Rough Estimated Cost

The total project cost is estimated roughly at 596 millions Japanese Yen, on the condition that the project will be implemented by Japan's grant aid scheme. As a breakdown of this cost, the Japanese side covers 578 millions Japanese Yen as shown in Table 2.5.1, and the cost to be born by the Ethiopian side is estimated at 18 millions Japanese Yen (equivalent to 1.34 millions Ethiopian Birr) as shown in Table 2.5.2. This Project cost is provisional and would be further examined by the Government of Japan for the approval of the Grant.

Table 2.5.1 Project Cost of Japanese Side

Component of the Works to be borne by Japanese Side		Estimated Cost (JY Million)	
Facilities	Construction of Water Supply Facilities for 9 target towns	431	482
Equipment	Procurement of Equipment for Well Rehabilitation	51	
Detailed Design, Construction Supervision, Soft Component			96
Total			578

Table 2.5.2 Project Cost of Ethiopian Side

Component of the Works to be borne by Ethiopian Side	Estimated Cost (JY Million)
1) Construction of Access Road to Intake Well in Kumami Town	17.0 (1,244,000 Birr)
2) Installation of Fences, Gates for Protection of 12 Wells	0.5 (36,000 Birr)
3) Installation of Fences, Gates for Protection of New Public Fountains in the Sites	0.8 (56,000 Birr)
Total	18.3 (1,336,000 Birr)

(2) Conditions for Estimation

1) Time of Estimation; May, 2006

2) Exchange Rate of Currency: 1.0 US Dollar = 118.42 Japanese Yen
1.0 Ethiopian Birr = 13.64 Japanese Yen

3) Estimated Schedule of the Project;

Detailed Design and Preparation of Tender documents : from December 2006 to July 2007

Tender Works and Construction of Facilities : from August 2007 to December 2008

4) Others: the project shall be conducted along with Japan's Grant Aid Guideline

2-5-2 Tariff Study

2-5-2-1 Recurrent Cost

Recurrent cost consists of consumables such as fuel and lubricant for electric generator, spare parts of machinery and salaries of staffs (pump operator, bill collector, accountant) and other costs necessary for daily management of the facilities. Monthly expenditures were estimated by taking account of the above costs in accordance with the scale of the proposed facilities. Recurrent cost was computed by the monthly expenditure divided by monthly water supply volume (based on daily average pumpage) in each site. Accordingly the costs of water production of the target sites range between 3.1 Birrs and 11.7 Birrs/m^3 as shown in the line ⑩ in Table 2.5.3. These costs were calculated samely at 8 – 29 Cents/25liters (per jerry can capacity) as shown in the line ⑪. The current water tariff at public fountain, confirmed through the socio-economic survey in the target towns, were ranged from 10 Cents/25L in Eli Wuha to 30 Cents/25L in Chifra. On the other hand, in Kumami, where inhabitants now buy water at 3 Birrs/25L from water venders who transport it from a town about 50 km far, the cost was calculated at 18 Cents/25L which is almost same level as other towns.

Table 2.5.3 Monthly Recurrent Cost and Cost Recovery (Unit：Birr)

Titems		Gubi Dowra	Kelewan	Derayitu	Chifra	Eli Wuha	Nemele'en	Wederage	Kumami	Dulecha
O/M Cost (Birr)	①Fuel	5,190	16,200	9,510	16,200	21,380	16,200	13,830	8,430	7,780
	②Salary	3,810	5,610	4,530	5,610	5,610	5,610	5,610	3,810	4,530
	③Mechanical consumables	500	1,330	1,100	1,390	1,530	1,590	1,500	820	1,000
	④Depreciation expence	460	1,280	1,020	1,360	1,520	1,460	1,380	790	920
	⑤Others (for Committee's activities)	160	160	160	160	160	160	160	160	160
	⑥Monthly O&M cost (=①+②+③+④+⑤)	10,120	24,580	16,320	24,720	30,200	25,020	22,480	14,010	14,390
Pumpage (m^3)	⑦Daily average pumpage	28.8	236.5	170.2	265.0	219.9	128.2	105.3	65.8	67.2
	⑧Monthly pumpage (=⑦x30)	864	7,095	5,106	7,950	6,597	3,846	3,159	1,974	2,016
	⑨Daily pumpage - leakage	735	6,033	4,341	6,759	5,607	3,270	2,685	1,677	1,713
Cost of Water (Birr)	⑩Cost per $1m^3$ (=⑥/⑧)	11.7	3.5	3.2	3.1	4.6	6.5	7.1	7.1	7.1
	⑪Cost per 25L (=⑩/40)	0.29	0.09	0.08	0.08	0.11	0.16	0.18	0.18	0.18
	Ref.：Current water price per 25L	0.25	0.20	0.25	0.30	0.10	0.25	0.20	*3.00	0.25
Case Studies (Assuming the water tariff 0.25 Birr/25L)	⑫ Case 1; 100% recovery of tariff to be charged (=0.25x40x⑨) (Birr)	7,350	60,330	43,410	67,590	56,070	32,700	26,850	16,770	17,130
	Balance (=⑫-⑥) (Birr)	-2,770	35,750	27,090	42,870	25,870	7,680	4,370	2,760	2,740
	⑬ Case 2; 80%recovery of tariff to be charged (=⑫x0.8) (Birr)	5,880	48,264	34,728	54,072	44,856	26,160	21,480	13,416	13,704
	Balance (⑬-⑥) (Birr)	-4,240	23,684	18,408	29,352	14,656	1,140	-1,000	-594	-686
	⑭ Case 3; 60%recovery of tariff to be charged (Birr)	4,410	36,198	26,046	40,554	33,642	19,620	16,110	10,062	10,278
	Balance (⑭-⑥) (Birr)	-5,710	11,618	9,726	15,834	3,442	-5,400	-6,370	-3,948	-4,112

＊Price of Kumami is the price of Water Vendor

2-5-2-2 Tariff Analysis

Cost recovery is examined in this Study. Water tariff for the cost recovery analysis was set, based on the comparison of the willingnesss-to-pay and the recurrent cost. The recurrent cost is calculated at 8-29

Cents/25L, and the willingnesss-to-pay has ranged from 20 to 25 Cents per 25L as a result of the socio-economic survey.

According to the present economic condition of the target towns, 25 Cents/25L seems to be an acceptable price in all the towns. Therefore, the analysis of cost recovery was made on the basis of water tariff of 25 Cents/25L. Case 1 is the case 100 % of bills are collected. Cases 2 and 3 are the 80% and 60% of bills of collected respectively. Consequently in case 1, Gubi Dowra only goes into the deficit of 2,770 Birrs. In case 2, towns of Wederage, Kumami, and Dulecha additionally go into the deficit. And in case 3, five towns, including Nemelefen, are added into the group of the deficit.

The results suggest that Water Committees should operate the facilities soundly and make effort to collect bill more than 90%. In case of Gubi Dowra town, it is suggested that AWRB subsidize deficit in bill collection from AWRB's annual budget. In any cases, new tariff setting is inevitable option in order to recover the recurrent cost.

2-6 Other Relevant Issues

2-6-1 Soft Component Plan

(1) Background

A program of capacity building (to be referred to as "Soft Component"), which intends to enhance the capacity of AWRB and Water Committees of the target towns, will be carried out on the occasion of implementation of the Project. In accordance with decentralization policy, administrative power is transferred from the central government to the regional governments. And public service is also managed by each regional government. In water sector, management of water supply service is basically handled by Water Desk at Woreda level or Water Committees, and Water Resource Bureaus of regional governments are mainly responsible for investigations, studies, administrative works in construction contract, supervision of construction, etc..

AWRB aims to make a good use of malfunctioned existing wells by means of well rehabilitation, and high priority was put on such plan. In line with this priority, a rehabilitation plan for the existing well was formulated in 2005, and budget and organizational arrangement for the activities have been in process in order to start the initiative in 2006. A maintenance service rig for shallow wells and a mobile workshop were supplied through the project implemented by MoWR and financed by the World Bank to the regional governments in 2002. Technical training on well rehabilitation was made to technical staff in regional governments, but insufficient. In order to complete well rehabilitation plan, AWRB has strongly expected that the related equipment will be complemented and technical skills of staff will be raised by the Project. In addition, shallow well and deepwell were drilled every year, and there have been high necessity to maintain and rehabilitate existing wells.

On the other hand, in 8 target towns, Water Committee or local group handles water supply management with an assistance of Water Desk. However, water supply management in a couple of the towns has been not well handled due to aged machinery, insufficient maintenance, lack of managerial capability. Especially for the managerial capabilities, educational assistance or training from Water Desk or AWRB was not made to Water Committee or Local group. This is why that the capacity building program (Soft Component) is proposed and included in the Project.

(2) Activities and Targeted Outcome

Soft Component is divided into two activities: 1) improvement on technical skill in well rehabilitation work for AWRB and 2) improvement on managerial capability in water supply for Water Committee.

The training for the improvement on technical skill in well rehabilitation work will focus on well rehabilitation method, pumping test, data analysis, and technical paperwork. And the training will consist of indoor lecture and on-the-job-training (OJT) that will be held at 3 existing wells. Well rehabilitation method will focus on the removal and the installation of the submersible motor pumps, rehabilitation methods of air-jetting method and bailing. Pumping test will focus on the purpose of the

test, data obtained through the test, etc. Data analysis will focus on well yield and optimum pumpage with using the data obtained in the pumping test. Technical paperwork will focus on working report, monitoring interval of groundwater, etc.

The training for improvement on managerial capability in water supply for Water Committee will focus on organization of Water Committee, financial management, and facility operation management. And the training will be carried out on the basis of participatory workshop. In addition, WSO and the staff of AWRB will be requested to participate in this training to follow up the activities of Water Committees. The organization of Water Committee will be targeted at the towns without Water Committee. Financial management will cover cost-recovery-oriented management, bill collection, bookkeeping, etc. Facility operation management will cover preventive inspection, switching on/off, operation record, etc.

The activities and target outcome are summarized in Table 2.6.1.

Table 2.6.1 Activities and Target Outcome of the Soft Component

Activities	Targeted Outcome
Improvement of Technical Skill on Well Rehabilitation	・ AWRB's technical skill on well rehabilitation is improved. ・ AWRB can tackle at well rehabilitation work.
Improvement of Managerial Capability on Water Supply	・ Water supply management is well handled by the Water Committees. ・ Water supply facilities is well maintained by WSO and AWRB

(3) Outputs

Outputs to be achieved through implementation of Soft Components are summarized in Table 2.6.2.

Table 2.6.2 Outputs to be Achieved

Components	Outputs
Improvement of Technical Skill on Well Rehabilitation	・ AWRB can carry out rehabilitation work focused on air-jetting method. ・ The pumpage is decided on the basis of the yield obtained pumping test. ・ Working report including rehabilitation work is always prepared. ・ Well inventories is systemized and well recorded.
Improvement of Managerial Capability on Water Supply	・ Water Committee is organized on condition that mutual agreements of concerned parties such as key personnel of the inhabitants, WSO, and AWRB. ・ AWRB and/or WSO carry out daily check-up, maintenance for existing water supply facilities. ・ Water Committee carries out financial management on cost-recovery basis. ・ Water Committee procures fuels and consumables for the facilities in appropriate and timely manners.

(4) Means of verification for Achievement and Outputs

Means of verification for progress are presented in Table 2.6.3.

Table 2.6.3 Outputs and Means of Verification

Components	Outputs	Criteria for Monitoring and Evaluation	Means of Verification	
			Means	Evaluator
Improvement of Technical Skill on Well Rehabilitation	AWRB can carry out rehabilitation work focused on air-jetting method	・Whether necessary preparatory work is made ・Whether removal and installation of submersible pump is made or not ・Whether air-jetting work is carried out in appropriate manner or not	Check sheet	Japanese Consultant
	The pumpage is decided on the basis of the yield obtained pumping test.	・Whether necessary preparatory work is made or not ・Whether pumping test is carried out in appropriate manner or not ・Whether data obtained in pumping test is analyzed or not		
	Working report including rehabilitation work is always prepared.	・Whether working report for rehabilitation work is always prepared or not		
	Well inventories is systemized and well recorded.	・Whether well data is built up or not		
Improvement of Managerial Capability on Water Supply	Water Committee is organized on condition that mutual agreements of concerned parties such as key personnel of the inhabitants, WSO, and AWRB.	・Whether committee members and composition of members are selected or not ・Whether agreement between the parties including respective roles is concluded or not	Check sheet	Japanese Consultant
	AWRB, WSO and Water Committee carry out daily check-up, maintenance for existing water supply facilities.	・Whether working our is recorded in daily check-up by Water Committee or not ・Whether regular inspection by WSO is recorded or not ・Whether necessary maintenance of the facilities is made by AWRB or WSO timely or not		
	Water Committee carries out financial management on cost-recovery basis.	・Whether water tariff reasonable for sound management is settled by Water Committer or not ・Whether bookkeeping is done by Water Committee or not		
	Water Committee procures fuels and consumables for the facilities in appropriate and timely manners.	・Whether fuel management including consumables is well done by Water Committee with assistance of WSO or AWRB or not		

(5) Activities (Input plan)

1） Improvement of Technical Skill on Well Rehabilitation

Concrete activities of the Improvement of Technical Skill on Well Rehabilitation are as follows:

i) Guidance on plan of operation,
ii) Operation, check-up, and preparation of equipment,
iii) Training on well rehabilitation,
iv) Training on pumping test,
v) Instruction on paperwork, and
vi) Evaluation of well rehabilitation works.

AWRB's own service rig together with the equipment to be newly procured by the Project will be used in this training. Thus, mechanical check-up for AWRB's own service rig is needed to carry out prior to the commencement of the training.

Training will be 10 days for preparation in Japan and about 2 months for lectures and OJT activities in Ethiopia. Detailed activities are presented in Table 2.6.4.

2） Improvement of Managerial Capability on Water Supply

Main activities of this component focus on the capacity building on water supply management for Water Committee in Project sites. Concrete activities are as follows:

i) Guidance/confirmation towards implementation of workshop,
ii) Workshop for organizing Water Committee,
iii) Workshop for the training necessary for water supply management, and
iv) Monitoring and evaluation of the Water Committees' activities

The workshops will be held on participatory basis. The workshop for organizing Water Committee will be held in Kumami Towns, and the workshop for the training necessary for water supply management will be held in the 9 towns.

This component will be 10 days for preparation in Japan and 2.3 months of training and instruction in Ethiopia. In 9 months after the completion of the above training and istruction, the evaluation on the Water Committees' activities will be carried out for 21 days. Suggestions will be given to AWRB and WSO to follow up, as a result of the evaluation. Detailed activities are shown in Table 2.6.5.

Table 2.6.4 Activities (Input Plan) for Improvement of Technical Skill on Well Rehabilitation

Activities	Detailed Activities	Target Group	Implementation Methods	*Duration	Resources for Implementation	Outputs
Guidance for Plan of Operation	・ Awareness sharing for objectives, contents, institutional arrangement and outputs of the Component at AWRB	AWRB	Guidance	5 days	Japanese Consultant	
Operation, check-up, and preparation of necessary equipment	・ Operation, check, coordination and preparation of necessary equipment before mobilizing to the Target sites	Ditto	Ditto	7 days	Japanese Consultant and local assistant	
Training on Well Rehabilitation	・ Lecture on purposes, methods and theories of well rehabilitation ・ Survey of current status of the existing wells and facilities at 3 towns ・ OJT on well rehabilitation by using equipment ・ Working Report	Ditto	Lecture and OJT	37 days	Japanese Consultant and local assistant	Manual for Well Rehabilitation
Training on Pumping Testing	・ Lecture on purposes, methods and theories of pumping test ・ OJT on pumping test by using equipment ・ Analysis of pumping test data ・ Working Report	Ditto	Ditto			Manual for Pumping Test
Instruction on paperwork	・ Instruction of recording well inventories ・ Suggestion on data collection, processing and management of well inventories	Ditto	Lecture	4 days	Japanese Consultant	Well Inventories
Evaluation of well rehabilitation works	・ Evaluation of jobs/tasks ・ Confirmation of issues and suggestions towards sustainability of jobs/tasks	AWRB	Seminar	5 days	Ditto	Check Sheet, Materials for Seminar

*Including Saturday and Sundays, days to move the site

Table 2.6.5 Activities (Input Plan) for Improvement of Managerial Capabilities on Water Supply

Activities	Detailed Activities	Target Group	Implementation Methods	* Duration	Resources for Implementation	Outputs
Guidance/ confirmation towards implementation of workshop	・ Sharing purpose, content, institutional arrangement, outputs of the training ・ Confirmation of preparatory works for the training	AWRB	Guidance	5 days	Japanese Consultant	
Workshop for organizing Water Committee	・ Preparing of community mobilization, ・ Selection of water committee member ・ Confirmation of the Water Committee's roles and responsibilities ・ Formation of water committee organization, activities and by-laws/articles	Key personnel in Woreda, WSO and AWRB	Lecture	4 days	Ditto	
Workshop for the training necessary for water supply management	・ Confirmation of the Water Committee's roles and responsibilities ・ Seminar on cost-recovery-oriented management ・ Seminar on water tariff ・ Seminar on financial management (bill collection, bookkeeping) ・ Seminar on facility operation management (switching on/off, fuel management, daily operation record, etc.) ・ WSO's preventive inspection and maintenance for the facilities ・ Establishment of fuel supply/procurement system ・ Establishment of spare-parts supply/procurement system ・ Establishment of communication channels, clarification of responsible bodies for tasks and measures	Water Committee members, WSO and AWRB	Workshop	61 days	Japanese Consultant, Local facilitator, assistant who speak (Amharic ⇔ Afar)	・ Agreement between the parties ・ New Water Tariff ・ Bookkeeping model ・ Daily inspection Sheet
Monitoring and evaluation of the Water Committees' activities	・ Lecture on monitoring of Water Committee's activities ・ Evaluation on completion of activities ・ Suggestion towards sustainability of activities	Water Committee members, WSO and AWRB	Seminar and workshop	21 days	Japanese Consultant	・ Monitoring manual, ・ Check sheet, ・ Materials for Seminar

*Including Saturday and Sundays, days to move the site.

(6) Means of Input of Human Resources

Training for the capacity buildings will be basically carried out by Japanese Consultant together with local assistant. In case of the training for Well Rehabilitations, local driller or specialist for Well Rehabilitation is available in Addis Ababa and regional capitals. There are a lot of construction enterprises for water works including governmental enterprises in Ethiopia. The enterprises are entrusted by the regional state government, and well drilling work is also entrusted. However, from the aspect of teaching capability, they are insufficient to carry out the technical transfer. In addition, the specialists in private enterprises are always tied up with the work that they are engaged in. For these reasons, a Japanese expert to be dispatched by the Japanese Consultant will carry out the training for Well Rehabilitations.

For the improvement of managerial capabilities on water supply a Japanese Consultant will carry out as well. In Ethiopia, management consultant is available, but the consultant who is familiar with the cultural and social characteristic of Afar region is limited. In addition, Afaric language is spoken in Project sites commonly. Amharic-language speaker is rather limited to public employees, but there are few women who understand Amharic language in the Study area. Considering these situation, a local facilitator, Anglo/Amharic-speaker, is deployed on contract basis to assist Japanese expert. And the training will be carried out by this team.

On the other hands, Japanese technical cooperation project namely “Groundwater development and Water Supply Training Program” (to be referred to as “the Training Center”) will start training course on well rehabilitation from 2006. However, detail schedule and content of the course is yet to finalize. In any way, it will be necessary to discuss with the experts of the Training Center on the content of the training course to be provided by the training center in order to follow up the technicians of AWRB.

(7) Plan of Operation

Plan of operation of the Soft components are depicted in Figure 2.6.1.

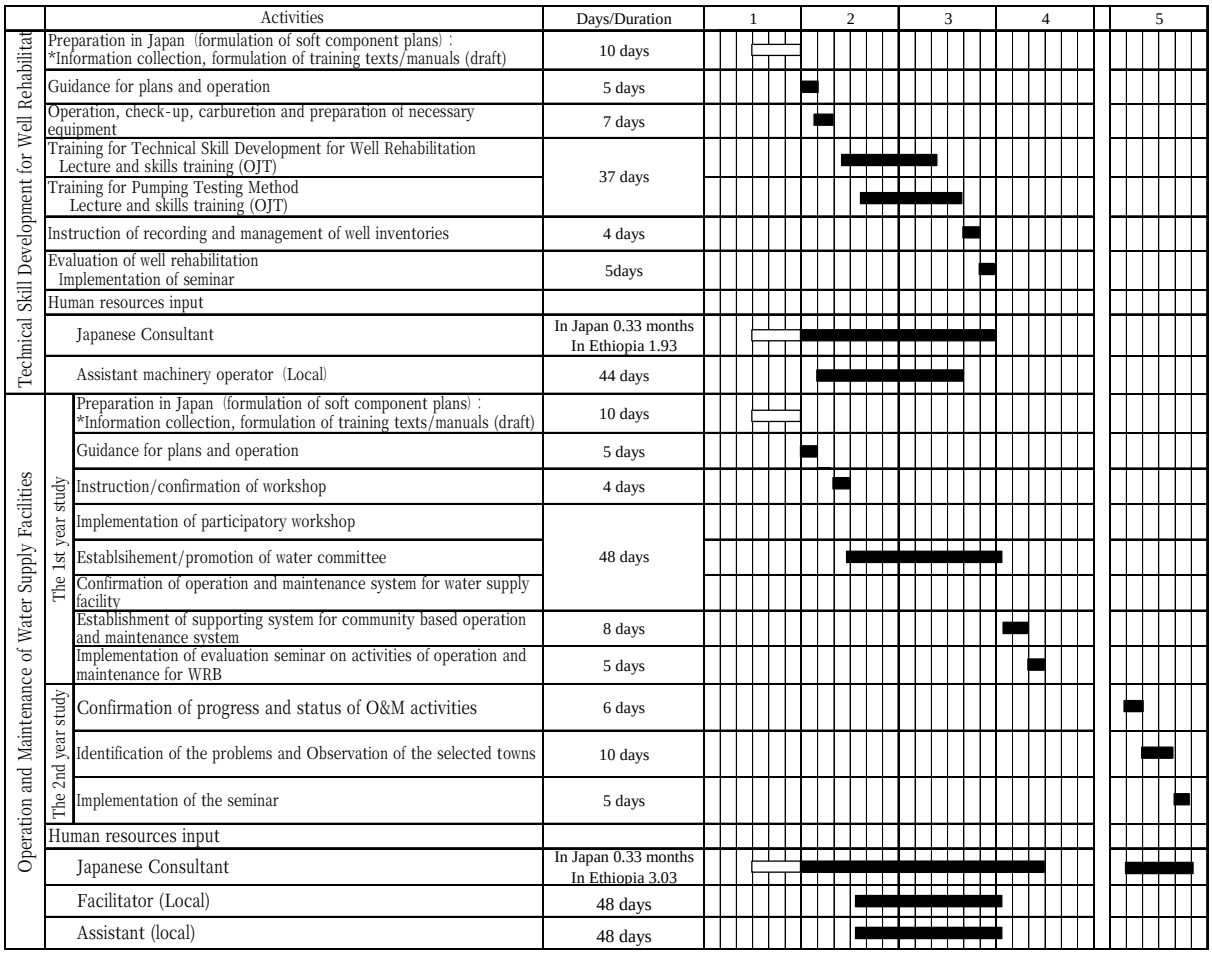


Fig. 2.6.1 Plans of Operation

(8) Outputs

Outputs to be submitted along with progress of respective activities are presented Table 2.6.4 and Table 2.6.5. In addition to the outputs shown hereafter, a completion report to both the Ethiopian and Japanese sides shall be made.

(9) Responsibilities of the Ethiopian Side

In order to implement the components, activities to be carried out by responsibilities of the Ethiopian side are as follows:

1) For both components

- The entire activities of O&M shall be implemented in cooperation with the Japanese consultants.
- Implementation and promotion of the Project shall be carried out in cooperation with the administration of the Target towns.

2) For the activities relating technical skill development for well rehabilitation

- Formulation of the task team by technical personnel,
- Provision of necessary equipment during implementation,
- Provision of allowances to staff to participate the activities,

- Provision of fuel for equipment to be used for the Soft Component,
- Implementation of well rehabilitation project in the Afar Regional State in future by AWRB, and
- Provision of venue for lecture, furniture, equipment and necessary supplies.

3) For the activities relating O&M of water supply facilities,

- Assignment of person in charge of particular activities from staff of AWRB,
- Arrangement for personnel of WSO in each target site to participate the activities,
- Coordination with relevant personnel in the respective town to request for cooperation, information delivery and guidance,
- Provision of allowances to the staff for participate the activities,
- Provision of venue for lecture, furniture, equipment and necessary supplies, and
- Implementation of regular monitoring and support on formulation and activities of Water Committee.

2-6-2 Reviews on Environmental & Social Considerations

2-6-2-1 Ethiopian Environmental Law and Regulations

(1) National Environmental Policy

The Environmental Policy in Ethiopia was established in 1997. The policies in water resources sector are:

1) To ensure that the control of environmental health hazards be a necessary condition in the design, construction and use of dams and irrigation systems,
2) To recognize that natural ecosystems, particularly wetlands and upstream forests, are fundamental in regulating water quality and quantity and to integrate their rehabilitation and protection into the conservation, development and management of water resources,
3) To ensure that any proposed introduction of exotic species into water ecosystems be subjected to detailed ecological studies and environmental impact assessment,
4) To promote the protection of the interface between water bodies and land.
5) As most large and medium scale irrigation potential is located in the rangelands of the lowlands occupied by pastoralists, to consider the opportunity costs of irrigating important dry season grazing areas of the pastoralists for crop production in any cost benefit analysis of such irrigation projects,
6) To involve water resource users, particularly woman and animal herders, in the planning, design, implementation and follow up in their localities of water policies, programs and projects so as to carry them out without affecting the ecological balance,
7) To subject all major water conservation, development and management projects to the environmental impact assessment process and to include the costs and benefits of protecting watershed forests, wetlands and other relevant key ecosystems in the economic analysis of such water projects,
8) To promote through on-site training, effective water management techniques at the farm level for improved performance of medium to large-scale irrigation schemes,
9) To promote, to extent possible, viable measurers to artificially recharge ground and surface water resources, and
10) To recycle waste water when it has been found to be safe for health and the environment or when it has been made safe without entailing high cost.

(2) Regulations and Guideline related to Environmental Impact Assessment (EIA)

The regulations of EIA in Ethiopia can be seen in Proclamation No.299/2002. The EIA guideline was enacted in 2000. In the guideline, the sector which there is obviously an influence in the environment is described and hence EIA study is necessary for the sector. The projects required full EIA in the sector of rural and urban water supply and sanitation are:

1) Construction of dams, impounding reservoirs with a surface area of 100 hectors,

2) Groundwater development for industrial, agricultural or urban water supply of greater than 4,000m^3/day,
3) Canalization and flood-relief works, and
4) Drainage plans in towns close to water bodies.

(3) Law and Regulations of Land Acquisition

Law and regulations of land acquisition have not been established in Ethiopia. All land is government-owned ground in Ethiopia. Therefore, it is not a necessity to purchase, rent land and to register to a central government. If the approval of the Afar state and Water Committee of project site will be obtained, it seems that it does not become a problem of land acquisition.

2-6-2-2 Implementation of EIA study in Ethiopia, Categorization of Project by JICA

(1) The Competent Agency

1) EPA

The Environmental Protection Authority (EPA) is the Competent Agency at the Federal level in Ethiopia. The authority is responsible for the following EIA process:

- Ensuring that proponent complies with requirements of the EIA process,
- Maintaining cooperation and consultation between the different sectorial agencies throughout the EIA process, and
- Evaluating and take decisions on the documents that arise from the EIA process.

An environmental section is supposed to be set up in each state, to guide concerning environmental protection, and to supervise in the provinces. In Afar state, an environmental section is set up in Agricultural and Natural Resource Bureau and plays the roles of guidance and supervision concerning the environment in Afar region.

2) MoWR

MoWR is a responsible agency of water resources sector in Ethiopia. However, MoWR itself does not touch to EIA work. Environmental Impact Monitoring & Evaluation Team is set up within the ministry and the guideline concerning the environmental monitoring is being made.

(2) Execution Condition of EIA in Ethiopia

EPA is set up for environmental protection. Proclamation No.295/2002 is promulgated for the establishment of the EPA and the role are recorded in that. Additionally, Proclamation No.299/2002 is promulgated for the execution of environmental assessment, and it is shown that EPA evaluates and judges the EIA report before the implementation of the projects which cause negative impacts to the natural and social environment.

(3) Categorization by JICA and its Reason

Since the JICA environmental social considerations guideline had not been settled on, investigation such as scoping to environmental and social considerations was not done at a request stage and a first preliminary study stage of this Project. Before this basic design JICA assumed category of the Project "B" in accordance with the JICA's new environmental and social considerations guideline then decided to conduct an Initial Environment Examination (IEE) in order to evaluate the category in this basic design. As the results of IEE done by the study team, it was confirmed that there would be no serious impact on natural and social environments by implementation of the Project. Therefore the category of the Project was revised to "C" through evaluation of JICA. The categories of B and C in the JICA environmental social considerations guideline are as follows;

B: There is a small possibility of occurrence of some impacts, that may affect a small and confined area and can also be attended to solve by normal measures.

C: There is no impact to be expected by implementation of the Project.

2-6-2-3 Initial Environmental Examination（IEE）

(1) Project Component

Project component is described in Chapter "2-1-3 Outline of the Project".

(2) Stakeholders' Meeting

The aggressive discussions and the exchange of views on water problems and needs were made in the stakeholders' meeting. As results of the meetings, there is not objection to the implementation of project and construction of water facility as people needs more drinking water. More details about stakeholders' meeting can be found in the socio-economic section (see Chapter 1-2-2).

2-6-2-4 Environmental and Social Conditions in Study Area

(1) Social Environment and Natural Environment

The information of the social environment and the natural environment are seen at Chapter "1-2 Situation of the Project Sites".

(2) Pollution

The region around the sites is little the traffic of the vehicle where the gasoline, diesel engine was used, and there is neither the atmosphere nor a noise problem in the traffic of the vehicle. The factory group that causes air pollution and water pollution does not exist. Problems such as the nitrate nitrogen and

fluoride are confirmed in the drinking water. The details about groundwater quality problem are described in the section of groundwater quality.

2-6-2-5 Scoping

(1) Environmental and Social Elements for Scoping

Concerning to environmental and social considerations by the implementation of this project, the environmental and social elements were selected from JICA guideline, and are shown in Table2.6.6. Then the level of the impact is rated by the field investigation and the interview to stakeholders, etc. The ratings based on JICA guidelines for environmental and social considerations are shown in Table 2.6.7.

Table 2.6.6 Environmental and Social Elements for Scoping

Social Environment	1	Involuntary Resettlement
	2	Local economy such as employment and livelihood, etc.
	3	Land use and utilization of local resources
	4	Social institutions such as social infrastructure and local decision-making institutions
	5	Existing social infrastructures and services
	6	The poor, indigenous and ethnic people
	7	Misdistribution of benefit and damage
	8	Cultural heritage
	9	Local conflict of interests
	10	Water Usage of Water Rights and Rights of Common
	11	Sanitation
	12	Hazards (Risk), Infectious diseases such as HIV/AID
Natural Environment	13	Topography and Geographical features
	14	Groundwater
	15	Soil Erosion
	16	Hydrological Situation
	17	Coastal Zone
	18	Flora, Fauna and Biodiversity
	19	Meteorology
	20	Landscape
	21	Global Warming
Pollution	22	Air Pollution
	23	Water Pollution
	24	Soil Contamination
	25	Waste
	26	Noise and Vibration
	27	Land Subsidence
	28	Offensive Odor
	29	Bottom Sediment
	30	Accidents

Table 2.6.7 Rating Based on JICA Guidelines for Environmental and Social Considerations

Category	Degree of impact
A	Serious impact is expected
B	Some impact is expected.
C	Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.)
D	No impact is expected.
＋	Positive impact is expected.

(2) Evaluation Results

The expected influence caused by environmental and social elements of this project is shown in following Table 2.6.8. The natural and social environments in each site are similar. This means that the degree of the influence in each site is almost same. Thus, the influence is summarized in one representative sheet.

1）Social environment

Construction of water supply facilities will not occupy the residential area. Therefore, the resettlement of local residence may not happen. During the implementation stage, a part of farm land may be used for the construction. In this case, the consideration shall be taken into to avoid agricultural activities such as seeding, harvesting, etc. Moreover, an objection to this project is not expected from the local people as for this project with public benefit.

2）Natural environment

An adjacent area of each site is a dwelling region or an agricultural region, and a valuable ecosystem does not exist. Then it is thought that the influence by the implementation of the project on natural environment is a little. The influence is suppressed to the minimum considering the amount of the groundwater decrease, the range of the influence, and the scale.

3）Pollution

It is expected that water pollution might not be caused by the construction. However, if water pollution occurs by any chance, the regular water quality measurement of the river water and groundwater can be monitored in spreading of deterioration of water quality and an immediate action to stop it can be taken.

Table 2.6.8 Check List for Scoping

Element	No	Item	Evaluation	Reason
Social Environment	1	Involuntary Resettlement	D	No involuntary resettlement will occur on each site during the implementation stage.
	2	Local economy such as employment and livelihood, etc.	+	When the construction of water supply system starts, the employment of the local people is expected.
	3	Land use and utilization of local resources	D	When the project starts, a part of land could be occupied on the site. In this case, the appropriate procedure will be taken by AWRB and the Woreda office. Moreover, an objection to this project is not expected from the local people as for this project with public benefit.
	4	Social institutions such as social infrastructure and local decision-making institutions	D	During the implementation stage, neither the social institutions nor the local decision-making institutions are violated because the contract with the construction companies is made and the violation is avoided. In addition, when the influence to the above institutions is caused in the local society, it is adjusted appropriately by the Woreda office and the head of Woreda.
	5	Existing social infrastructures and services	D	No impact to the existing schools and hospitals is expected.
	6	The poor, indigenous and ethnic people	D	It is not assumed that the implementation of this project influences the people who belong to a weak group such as pastoral people harmfully.
	7	Misdistribution of benefit and damage	D	Various problems in the local society like the misdistribution of benefit and damage are adjusted by the Woreda office and the head of Wareda. This project does not cause damage and inconvenience to the local society directly and indirectly since the proper contract with the construction companies are made and the project is executed by them.
	8	Cultural heritage	D	In the vicinity of project area, of the object, neither the cultural heritage nor the cultural ruins, asset exists.
	9	Local conflict of interests	D	Various problems of the conflict of interest in the region are adjusted by the Woreda assembly and the head of Woreda. It is not assumed that this project influences the conflict of interest in the region.
	10	Water Usage of Water Rights and Rights of Common	D	The water usage is temporary and quantitatively little although it is assumed that water is used when mud drilling for water well construction carry out, and the structure material (concrete) are used.
	11	Sanitation	D	Urine etc. are treated properly in this project, especially the appropriate treatment will be done during the construction.
	12	Hazards (Risk) Infectious diseases such as HIV/AID	D	An occupational health hazards to a worker during construction are appropriately educated by the construction management.
Natural Environment	13	Topography and Geographical features	D	Rift valley exists as geographical features. However there is no impact to it.
	14	Groundwater	D	No serious impact to declination of groundwater level of the existing well is expected by keeping an enough distance between wells.
	15	Soil Erosion	D	No deforestation which causes the soil erosion is done in this project.

	16	Hydrological situation	D	The structure will not be constructed in the river.
	17	Coastal Zone	D	No impact is expected. There is not costal zone in study area.
	18	Flora, Fauna and Biodiversity	D	Neither an important ecosystem nor the flora, fauna exist in the sites.
	19	Meteorology	D	No impact to weather is expected.
	20	Landscape	D	There is no sightseeing spot around study area. The change by the appearance of the structure in the reservoir tank etc. does not cause a serious environmental problem and impact to some views and the spectacle components.
	21	Global Warming	D	The implementation of this project does not influence on global warming.
Pollution	22	Air Pollution	D	In the project site, the car traffic does not cause air pollution. Construction dust can be prevented by proper management.
	23	Water Pollution	D	No serious impact related to water pollution is expected.
	24	Soil Contamination	D	In this project, the materials such as heavy metals that influences on the soil contamination are not used.
	25	Waste	D	Waste is appropriately processed although the waste is expected to produce during the construction. Also the amount of waste can be reduced by proper construction management.
	26	Noise and Vibration	D	As construction is mainly carried out in daytime and proper construction management is done, the influence can be suppressed to minimum although the noise and the vibration are assumed by operating the construction equipment during the construction stage of this project.
	27	Land Subsidence	D	There is no soft soil which causes land subsidence in the project area.
	28	Offensive Odor	D	No impact is expected.
	29	Bottom Sediment	D	No impact is expected.
	30	Accidents	D	No impact is expected. Accidents can be prevented by management of construction work.

2-6-2-6 Necessity of Future Study of Environmental and Social Consideration

As mentioned in the former chapter, no impact on environmental and social consideration is expected on the occasion of the implementation of the Project. Therefore it was confirmed that there was not necessity to conduct farther investigation on environmental and social consideration on this Project. However, it is recommended to establish a monitoring system on groundwater level sand yields from the aspect of O&M of the facilities.

With regard to groundwater development project the Ethiopian Guideline requires to implement EIA, however, this Project is eliminated from the regulation due to its small volume of utilization of groundwater.

CHAPTER 3. PROJECT EVALUATION AND RECOMMENDATIONS

Chapter 3 Evaluation and Recommendations

3-1 Project Effects

(1) Direct Effects

The Project is basically composed of three components: 1) the construction of water supply facilities for 9 towns, 2) the procurement of the equipment for the well rehabilitation, and 3) the soft component. The beneficial effects of these components can be summarized as follows.

Table 3.1.1 Effects and Improved Aspects

Present Situation	Measures taken in the Project	Effects and Improved Aspects
There are serious water shortages in the Project towns, and the inhabitants in those towns waste time on fetching the water. Especially for the female and children, fetching water is a heavy burden to them.	To construct water supply facilities for 9 towns meet water demands at the target year of 2010.	The Project can supply good water on quantity and quality. Water supply coverage rate will improve from 49.8% to 75.6%, and the served population will increased from 16,320 to 34,350, as well.
AWRB has the well rehabilitation scheme, covering the whole existing malfunctioned wells in the region. However, it is quite difficult to carry on by only one service rig.	To procure a set of well rehabilitation equipment including the related accessories.	AWRB can tackle at the well rehabilitation scheme.
Technique of AWRB on well rehabilitation work is insufficient to carry out.	To conduct Soft Component related to well rehabilitation.	The technique of AWRB will be improved, and the functional wells will be increased.
There are some towns without any Water Committee in the Project towns, and also there are some towns where is a malfunctioned Water Committee.	To organize Water Committees and to conduct Soft Component related to the capacity building on the overall management of water supply.	Water Committees will be set up in all the target towns, and their skills on overall management of water supply will be improved.

1) The construction of water supply facilities for 9 towns

- On completion of the Project, the water supply coverage in 9 towns will improve from 49.4% to 75.6%, and similarly, the served population will increase from 16,320 to 34,350.
- The water supply volume in the towns will increase from 408 m^3/day to 1,702 m^3/day.
- The inhabitants in the Project towns will be rathere relieved of burden of fetching the drinking water.

2) The procurement of the equipment for the well rehabilitation

The following effects are expected by the Equipment Procurement.

- AWRB can tackle at the rehabilitation works for the existing malfunctioned wells in accordance with the program.
- Water supply coverage in Afar region will be increased according to the increase of the rehabilitated wells.

3) Soft Component

Soft Component related to capacity building aims at the personnel of AWRB, WSO, and the Water Committee. Soft Component will have enabled as follows:

- The skill of AWRB's staff in the field of the well rehabilitation will be enhanced, and they can take actions to formulate the well rehabilitation program efficiently.
- The skill of WSO's staff in assisting Water Committee will be enhanced, and they can give the trainings on the managerial capacity to Water Committee regularly.
- Water Committee can manage water supply on the cost-recovery-oriented basis.

(2) Indirect Effects

The indirect effects of the Project are expected as follows.

- Stable water supply on quality and quantity renders to the reduction of the water-born diseases such as diarrhea, intestinal parasite, malaria, typhoid, etc.
- The female inhabitants will have more chances to participate in the social activities, and the children can have more chances to get the education due to saving the time to fetch the water.

3-2 Recommendations

In order to implement the Project smoothly and efficiently, it is recommended to take actions for following issues.

(1) Deploying Additional Personnel in O&M Department in AWRB

Soft Component on the improvement of well rehabilitation skill will be conducted for the staff of the O&M department in AWRB. However, the organizational set up of the O&M department is being reformed in order to enable the staff to do better performance. Therefore, it is highly required to finalize the reform of the organizational set up and deploy additional personnel prior to the implementation of the soft component.

(2) Deploying Necessary Personnel in WSO in Woreda

WSO is set up instead of the previous Water Desk and will be responsible for assisting the Water

Committee in supporting water supply management. In addition, Soft Component related to the capacity building of Water Committee is planned to implement together with the staff of WSO. Therefore, it is needed to deploy new staff in WSO prior to the implementation of the soft component.

(3) Ensuring Budgeting for Implementation of the Project

The Project is divided into two portions to be carried out by the Governments of Ethiopia and Japan. The Ethiopian portion, which is stated in this report (see Chapter 2-3) as the obligations and responsibilities of the Ethiopian government, shall be budgeted prior to the implementation of the Project in order to run on schedule.

(4) Consideration for Rainy Season

In rainy season, rural roads become muddy, so that access from the town to the well and generator house is very difficult. Under such condition it is sometimes difficult to bring the fuel to the generator house. In order for Water Committee to maintain the facility steady, it is recommended for AWRB to take proper measures for such difficulties, for instance, increasing a fuel stock, constructing gravel road, etc.

(5) Organizing Water Committee and Capacity Building

It is required to organize Water Committee in a couple of towns and to give the training of capacity building to the Water Committee after organizing the committee. These works will be conducted as a technical transfer of Soft Component, and it is necessary for the staff of Department of Community Participation and Coordination of NGOs to participate in this works. Therefore, it is recommended to make a necessary arrangement for this matter prior to the implementation of this technical transfer.