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

2-2-2-1 Construction Plan

(1) Overall Plan

1) Target Year of Plan

Target year of this project is set to year of 2015, which the year about 2 to 3 years after the completion of the facility construction.

2) Target Site

a. Water supply facilities with hand pump

82 sites were selected through the screening by the criteria

b. Motorized Pump water supply system with pipe facilities

12 sites were selected after the field survey and test drilling

c. Rehabilitation of water supply system

3 sites were selected through field survey and screening by the criteria

3) Target Served Population

Target served population was calculated based on the site population listed in the requested list (2006) by TWRMEB. The annual population growth rate of 2.23% (Source: Technical Design Standard in Tigray Region) has been applied.

4) Planned Water Supply

Planned water supply will be calculated by using the figure of water supply standard (liter/capita/day) and planned served population. Demand for the public facilities such as hospitals and schools are also considered. Water supply for livestock is not considered, as requested. Table 2-11 shows planned water supply in 2015 for Level 2 for the respective villages and Table 2-12 shows planned water supply for rehabilitation facility

Table 2-11: Planned Water Supply Population and Planned Water Supply
(New Facility with Pipe System)

Fac. No.	Target Region for Water Supply		Present Water Supply Population (yr 2006)	Planned Water Supply Population (yr 2015)	No. of Teachers, Students	No. of patients, Staff	Churches	Mosque	Ave water supply/day(per facility) (L/s)	Max. water supply/day (per site) (L/s)	Max. water supply/day (per facility) (L/s)	Time max. supply (per facility) (L/s)	Source capacity (L/s)
	Woreda	Site											
1	Alamata	Gerjele town	4,100	5,000	1,280	111	61	79	1.253	1.504	1.504	3.610	5.600
2		Ula	2,150	2,622	500				0.601	0.721	0.721	1.730	3.000
3	Raya Azebo	Hadealga	2,000	2,439	551	48			1.373	0.703	1.647	3.953	5.600
		Keyih tekli	3,000	3,659	231					0.944			
4		Hirka	1,500	1,829					1.601	0.458	1.920	4.608	5.600
		Adialebachele	3,000	3,659	500					0.980			
		Bechenrkatan	1,580	1,927						0.482			
5		Fondel	1,250	1,524					0.318	0.382	0.382	0.917	1.000
6		Dodota	1,750	2,134	240				0.470	0.564	0.564	1.354	1.000
7		Hadiskign	1,685	2,055	258				0.457	0.548	0.548	1.315	2.000
8		Gemed dadi	1,035	1,262					0.263	0.316	0.316	0.758	5.000
9		tachgubegala	1,135	1,384					0.288	0.346	0.346	0.830	5.600
Total			24,185	29,494	3,560	159	61	79					

Rate of population increas 2.23%

Source: Basic Design Study Report on the Project for Rural Water Supply in Tigray Region

Table 2-12: Planned Water Supply Population and Planned Water Supply
(Rehabilitation Facility)

Fac. No.	Target Region for Water Supply		Present Water Supply Population (yr 2006)	Planned Water Supply Population (yr 2015)	No. of Teachers, Students	No. of patients, Staff	Churches	Mosque	Ave water supply/day (L/s)	Max. water supply/day (L/s)	Time max. supply supply/day (L/s)	Source Capacity※ (L/s)
	Woreda	Site										
10	Raya Azebo	Deletie	255	311					0.065	0.078	0.156	1.000
11		Kepan	600	732					0.152	0.182	0.365	7.000
12		Genete	226	276					0.058	0.070	0.139	2.000
Total			1,081	1,319	0	0	0	0				

Rate of population increas 2.23%

※Discharge rate based on discharge capacity of existing water sources through intervies.

Source: Basic Design Study Report on the Project for Rural Water Supply in Tigray Region

(2) Condition of Well Design

1) Well construction sites

a. Level 1

Where the aquifer is distributed homogeneously in alluvial deposits and in sedimentary rock, the drilling point will be decided based on the morphological feature of the village and the opinion of the residents, by ease of access to the community in the area. In the basement rock area, the sites for well construction will be decided from the position of the coordinate planned by the Basic Design Study.

In addition, the alternative drilling position will be selected by the Consultant in execution of construction for Level 1 water supply facilities.

b. Level 2

Basically, the boreholes drilled in of the Basic Design Study will be used. In case those boreholes were not drilled in this study or borehole diameter is too small for fitting required pump specification, new boreholes will be drilled in surrounding existing boreholes.

2) Well minimum discharge

a. Level 1

Taking into account Afridev type hand pump actual yield capability and operating ratio, the minimal output should be 15 liters/minute (0.25 liters/second).

b. Level 2

In principal, the water volume at each facility shall be able to satisfy water demand with 7 hours of pumping.

3) Water Quality Conditions

For this project, the Ethiopian drinking water quality standard based on the WHO standard shall be applied as is.

a. Water quality test at site

- The on-site water quality test will be conducted using portable water quality meters.
- The on-site water quality test will be conducted after water sampling without delay.
- The testing parameter measurement values for the four items shown below, pH, EC (electric conductivity), arsenic, and water temperature shall be those at the time of water sampling.
- Any abnormality is seen in the measurement value when conducting the on-site water quality test shall be re-tested for the corresponding parameter in a laboratory.

Table 2-13: Criteria for target items and water quality estimation (Site Analysis)

Item	Ethiopian Standard	Instrument used
Water Temp (℃)	-	Portable temp gauge
pH	6.5 to 8.5	Portable pH meter
EC (electric conductivity)	-	Portable EC meter
Arsenic	0.01mg/L	Field Kit

b. Water quality test at laboratory

- Laboratory water testing, in principal, will be trusted to an analysis institution in Addis Ababa (Ethiopia Geological Survey, or Water Works Design and Supervision Enterprise Laboratory Service).
- Concerning the method of transportation and storage of test water, testing will be conducted under appropriate conditions as directed by the analysis institution. These methods will be reported to the consultant for approval.
- The parameters targeted for laboratory water testing shall be the following 23 items.

Table 2-14: Criteria for target items and water quality estimation (Laboratory Analysis)

Items to be tested	Ethiopian Standard		Exam Place Lab	Remarks
	Health-hazardous Substances (Maximum allowable value)	Objectionable Level		
Boron	0.3 mg/ℓ	-	○	
Chromium	0.1 mg/ℓ	-	○	
Copper	5 mg/ℓ	-	○	
Fluoride	3.0 mg/ℓ	-	○	
Manganese	0.8 mg/ℓ	-	○	
Nitrate	50 mg/ℓ	-	○	
Nitrite	6 mg/ℓ	-	○	
Aluminum	-	0.4 mg/ℓ	○	
Ammonia	-	2 mg/ℓ	○	
Chloride	-	533 mg/ℓ	○	
Hardness	-	392 mg/ℓ	○	
Iron	-	0.4 mg/ℓ	○	
Hydrogen Sulfide		0.07 mg/ℓ		
Sodium	-	358 mg/ℓ	○	
Sulfate	-	483 mg/ℓ	○	
Total dissolved solids	-	1776 mg/ℓ	○	
Calcium	-	-	○	
Alkalinity	-	-	○	
E. coli	Not tested	-	○	
Chromaticity	-	22 TCU	○	
Odor	-	No odor	○	
Taste	-	Not unpleasant	○	
Turbidity	-	7 NTU	○	

Also, in limestone areas of the concerned area, the groundwater distribution originating in the gypsum layer contains comparatively high concentrations of calcium sulfate. In some of the villages where the water tastes bad, as abandoned wells can be found, for groundwater that has been polluted with calcium sulfate shall 1) use the sealing for the gypsum layer 2) examine avoidance measures to at the time of well construction such as selecting a separate water-intake aquifer.

4) Well Structure Criteria

The geological conditions of each site, drilling depth and well type is shown in Table 2-15.

1. Geological Character of Drilling Site

Within the 89 locations for drill target sites, there are three types of formation that appear which can be generally categorized as a loose layer (gravel mixed with boulder), sedimentary rock/basalt (soft rock), and a sedimentary/basement rock (hard rock).

2. Well Drilling Method

The following two types of drilling methods will be used to drill the wells.

- Down-the-Hole drilling method using an air hammer (hereinafter, DTH method)
- Mud Rotary Drilling method (hereinafter, Mud drilling)

In the project area concerned, the two methods are used; however with the prevalence of semi-hard - hard rock area, the DTH method will be used for a large part of the drilling. The loose layer drilling will fundamentally be Mud drilling, however where boulders are mixed in, the DTH method may be used where applicable.

For loose layers (gravel mixed with boulder), which are susceptible to borehole collapse during drilling, the drilling should employ a protective support casing which is lowered into the borehole and using the DTH method as a countermeasure against collapse (drilling is done at a large diameter, installing the support casing, and then continuing to drill to a lower level using a hammer bit with a diameter smaller than the casing). For Mud drilling, making adjustments for the specific gravity of the circulated mud, the mud acts to stabilize the borehole wall.

From the viewpoint of efficiency, basement rock favors the DTH method whereas a loose layer favors Mud drilling, but locations that exhibit a mixture of both strata, rather than modifying the method halfway, selecting one uniform method is more efficient. Due to this fact, Mud drilling and DTH method will be employed consistently as applies to the make up of strata as shown below.

From this, it can be seen that the proportion of drilling depth will be roughly 30% Mud drilling and 70% DTH method.

- Mud Rotary Drilling method
  - －A site where a loose layer continues to the base of the borehole
  - －a site where 50 m or more of loose layer drilling is followed by basement rock
- DTH Hammer method
  - －A site where, excluding the surface layer, nearly the entire area is made up of sedimentary and basalt rock
  - －A site where there is the appearance of basement rock within 20m below the surface

The drilling method for each site was determined based on the result of resistivity distribution gained from the electrical sounding results and hydro-geological field reconnaissance.

Table 2-15: Well Type of Each Geologic Sector, Drill Method, Quantity, Avg. Drill Depth

Geological Layer Classification	Well Type	Drilling Method	No. of Drilling	Avg. Drilling Depth (m)
Alluvial Layer (gravel mixed with boulder – sandy soil mixed with gravel)	Type I	Mud Rotary Drilling	17	100
Sedimentary Rock (mostly limestone) and Basalt Rock	Type II	DTH Hammer	21	95
Other Sedimentary/Basement Rock	Type III1	DTH Hammer	44	83
Alluvial Layer (gravel mixed with boulder – sandy soil mixed with gravel	Type Ⅳ-1	Mud Rotary Drilling	2	140
	Type Ⅳ-2	Mud Rotary Drilling	1	82
	Type Ⅴ	Mud Rotary Drilling	3	116
Total			88	-

5) Well Drilling Depth

The composition of each geologic layer and the existing well inventory offered hints to estimate groundwater aquifers and determine well depth. From those results, the minimum drilling depth is 60m, and the maximum length of drilling depth is 150m, giving an average depth of 91m. In basement rock areas, because drilling will be done basically targeting fissure type aquifers, the intersections with the fissure system of water tapped fissure is important. Accordingly, it is necessary to grasp the tectonic line by interpreting aerial photos and from geological field exploration. Because of the obscurity of potential groundwater reserves that accompanies this type of fissure system, the drill extension shall be deeper so that the chance to intersect water bearing fissures becomes higher.

6) Screen Casing

Due to the many cases in this project where the aquifer distribution of this area is uneven, the screen position and estimating the range is difficult. Therefore, with the well inventory as reference, the ratio of the total length of the screen has been estimated at 10:3.

When the drilling is being executed, the drilling slime will be judged, discharge during drilling will be recorded periodical and the electrical logging will be executed, and after specifying the depth of aquifer, the screen will be installed in the appropriate location.

Table 2-16: Drill Extension and Comprehensive Screen Length by Well Type

Geological Layer Classification	Well Type	No. of Drilling	Avg. Drilling Depth (m)	Drilling Depth Aggregation (m)	Total Screen Length (m)
Alluvial Layer (gravel mixed with boulder – sandy soil mixed with gravel)	Type I	17	100	1,700	510
Sedimentary Rock (mostly limestone) and Basalt Rock	Type II	21	95	1,995	599
Other Sedimentary/Basement Rock	Type III1	44	83	3,652	1,096
Alluvial Layer (gravel mixed with boulder – sandy soil mixed with gravel	Type Ⅳ-1	2	140	280	84
	Type Ⅳ-2	1	82	82	25
	Type Ⅴ	3	116	348	105
Total		88	-	-	2,419

7) Well Structure and Borehole Diameter

Basically there are 4 patterns for well structure, shown below per geologic layer type.

Table 2-17: Type of Well Structure and Bore Diameter

Structure Type	Geological Layer	Target Well	Borehole Diameter
Type I	Alluvial Layer	4-inch PVC for hand pump	8-1/2 inch or greater
Type II	Sedimentary Rock and Basalt Rock	4-inch PVC for hand pump	8-1/2 inch or greater
Type III	Other Sedimentary and Basement Rock	4-inch PVC for hand pump	6-1/2 inch or greater
Type IV	Alluvial Layer	6-inch PVC for submersible pump	9-7/8 inch or greater
Type Ⅴ	Alluvial Layer	8-inch PVC for submersible pump	12-1/4 inch or greater

Because the possibility for collapse of borehole wall is high for Type I and Type II above, as a necessary measure to extend the lifespan of the well, gravel fill is placed around the circumference of the screen (while this ensures that water passes through, it protects against sand penetrating and the stabilization fill also defends against borehole collapse). A clearance of 3 to 4 cm in width is necessary around the outer circumference of a 4-inch diameter casing, so that the borehole diameter comes to 18 cm or more. Furthermore, in the Type II, cement grouting is done to prevent contamination from the gypsum layer.

In Type III, the borehole wall is highly self-reliant in the basement rock, and support using grouting and the like is unnecessary so that the drilling outer diameter should measure 6 ½ inches or greater.

In order to guarantee the clearance which is necessary in order to insert a submersible pump in regard to a Type IV and Type Ⅴ (for Level 2), the casing is made to be 6 ~ 8 inches.

Also, especially in alluvium deposit areas, where the well structure is damaged, sand invades the well. As this becomes a large problem in regard to maintenance control, thick-walled casing is used to increase tolerance against borehole collapse, devised to extend the life of the well. The standard well structure which is best suited for particular areas are shown Figure 2-2, Figure 2-3 classified by type.

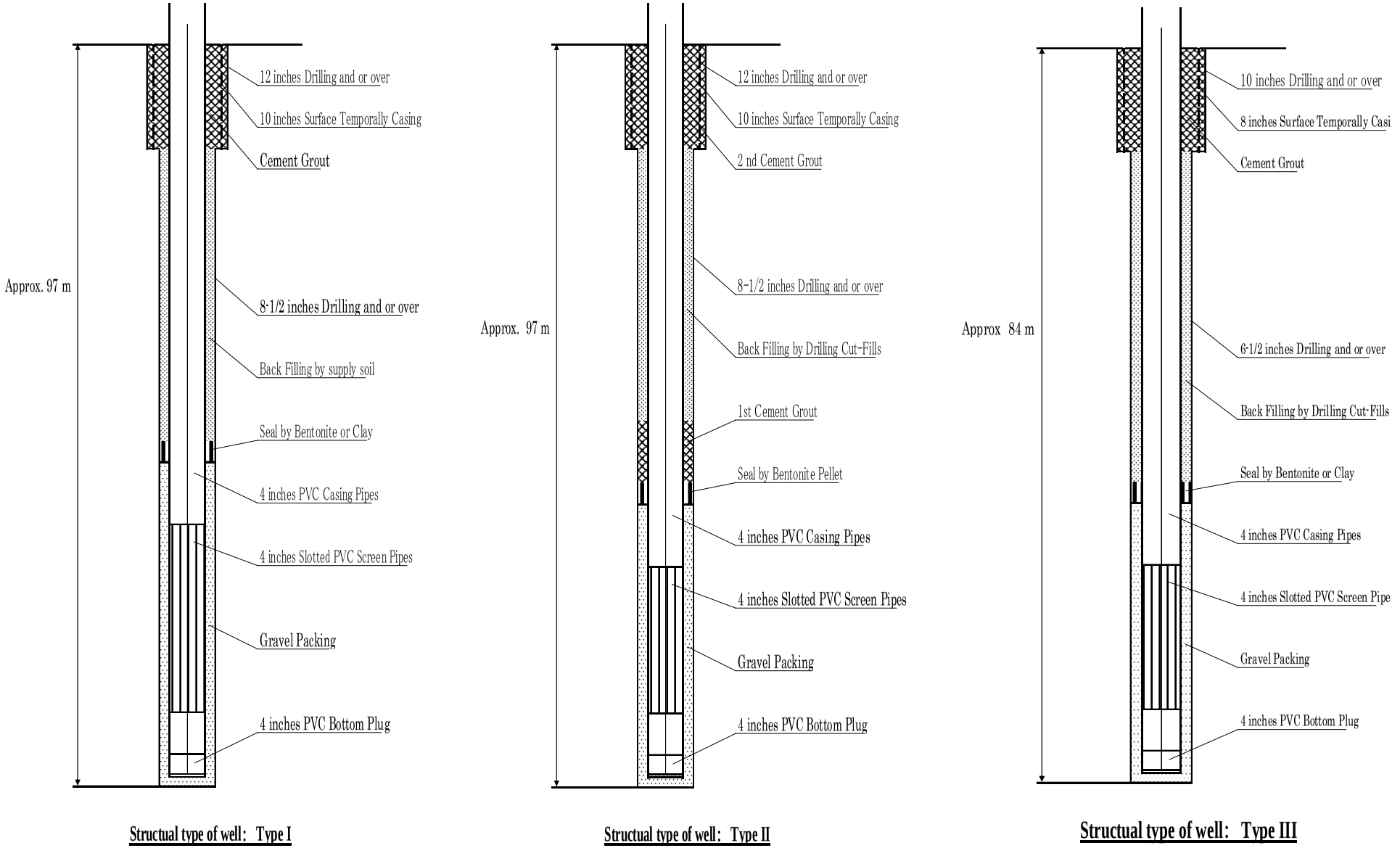


Figure 2-2: Standard Well Structure for Hand Pump by Geologic Type

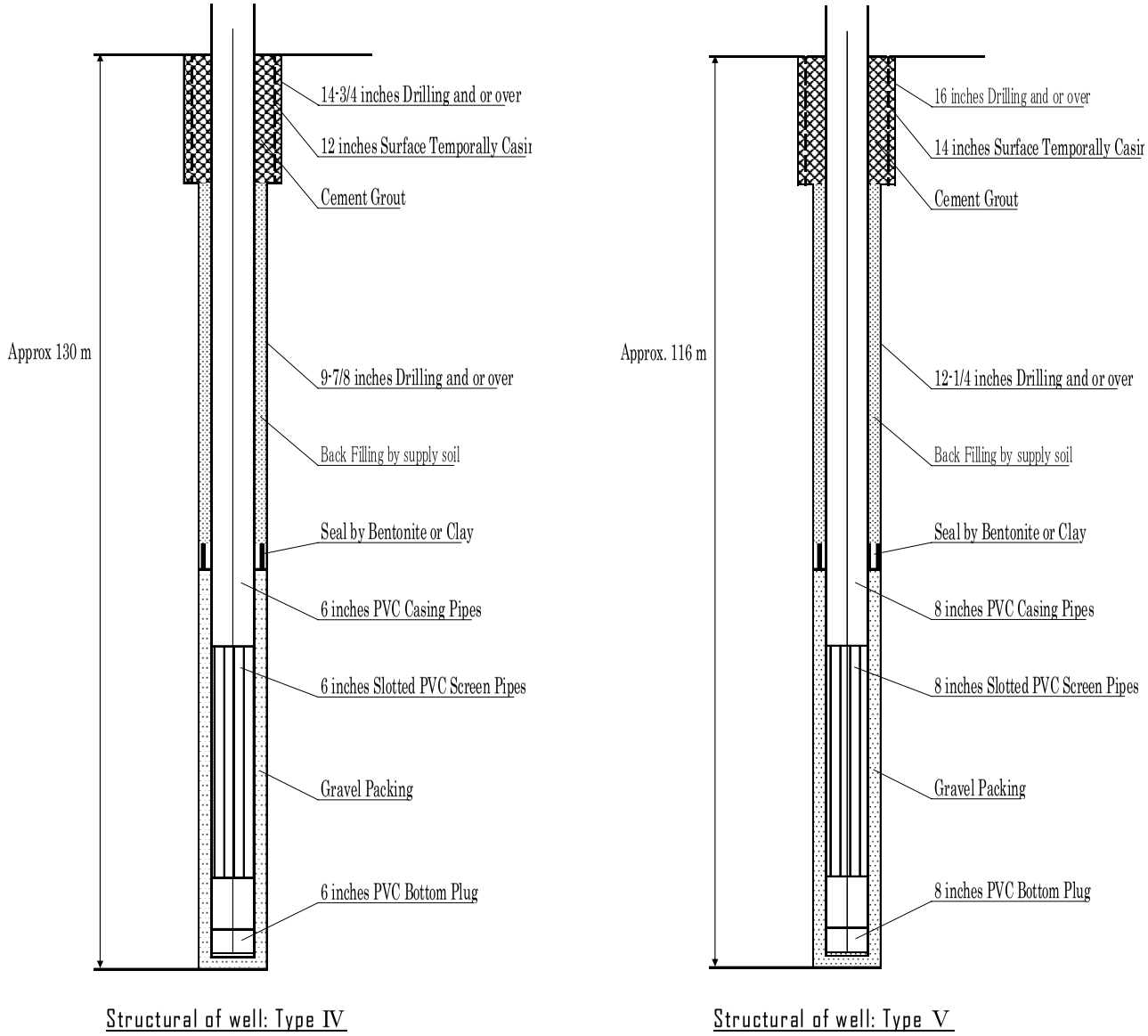


Figure 2-3: Standard Well Structure for Motorized Pump by Geologic Type

8) Well Drilling Success Ratio

Computation of the success ratio of the well used the drilling results from the past 5 years of the Tigray Water Works Construction Enterprise (TWWCE) containing data for 197 wells. The result was a 71% success ratio overall, almost equal to the latest drill testing survey results (69%).

For this project, the success ratio is divided into the two categories below from the constitution of the geological features of each Woreda.

Table 2-18: Well Success Ratio by Geology Target

Geologic Section by Region	Woreda Name	TWCCE Data		Success Ratio (%)
		Wells Drilled	Failure	
Alluvial Deposits, Sedimentary Rock and Basalt Rock Region	Kilte Awlealo, Enderta, Hintaro Wajirat, Raya Azebo, Alamata	90	21	Alluvial Deposits, Sedimentary Rock and Basalt Rock Region
Basement rock Region	Hawzen, Kola Temben, Degua Temben, Tanqua Abergele, Sharti Samre	107	36	Basement rock Region

Source: TWWCE (year of 2001～2006)

9) Well Success/Failure

The flow chart to determine the success or failure of the wells is shown below.

Table 2-19: Condition of Well Success

Item	Condition
Pumping Yield	・Level 1: in principal, 15L/min or greater is successful ・Level 2: in principal, provides enough to cover 7 hours of water demand at each site
Water quality	Anything that exceeds the Ethiopian water quality standards shall be unsuccessful.
Water level	・Level 1: Dynamic level of 45m or less from surface

Table 2-20: Discharge for Level 2 water supply facilities

ID No.	Woreda	Site	Discharge (L/min)
JAL004	Alamata	Gerjele town	312
JAL005	Alamata	Ula	150
JRA001	Raya Azebo	Hadealga	336
JRA002	Raya Azebo	Hirka	306
JRA003	Raya Azebo	Fondel	60
JRA007	Raya Azebo	Tachgubegala	72

The work that is necessary to confirm discharge, dynamic water level and water quality for judgment for successful well is shown below.

For mud drilling, making adjustments for the specific gravity of the circulated mud, the mud acts to stabilize the borehole well, thus well development is necessary for execution of the pumping test and water quality analysis, it is necessary to be completed to casing installation and filter gravel packing.

The DTH method, will be used for semi-hard, hard rock area, because borehole is comparatively stable, pumping test is done before casing installation.

However, in case of dry-hole, pumping test and water quality analysis are not conducted.

Table 2-21: Necessary work for judgment of successful well

Drilling method	Drilling	Casing installation	Development	Pumping test	Water quality analysis
Mud Rotary Drilling	○	○	○	○	○
DTH Hammer	○	×	×	○	○

The flow chart for well drilling is show in Figure 2-4, Figure 2-5.

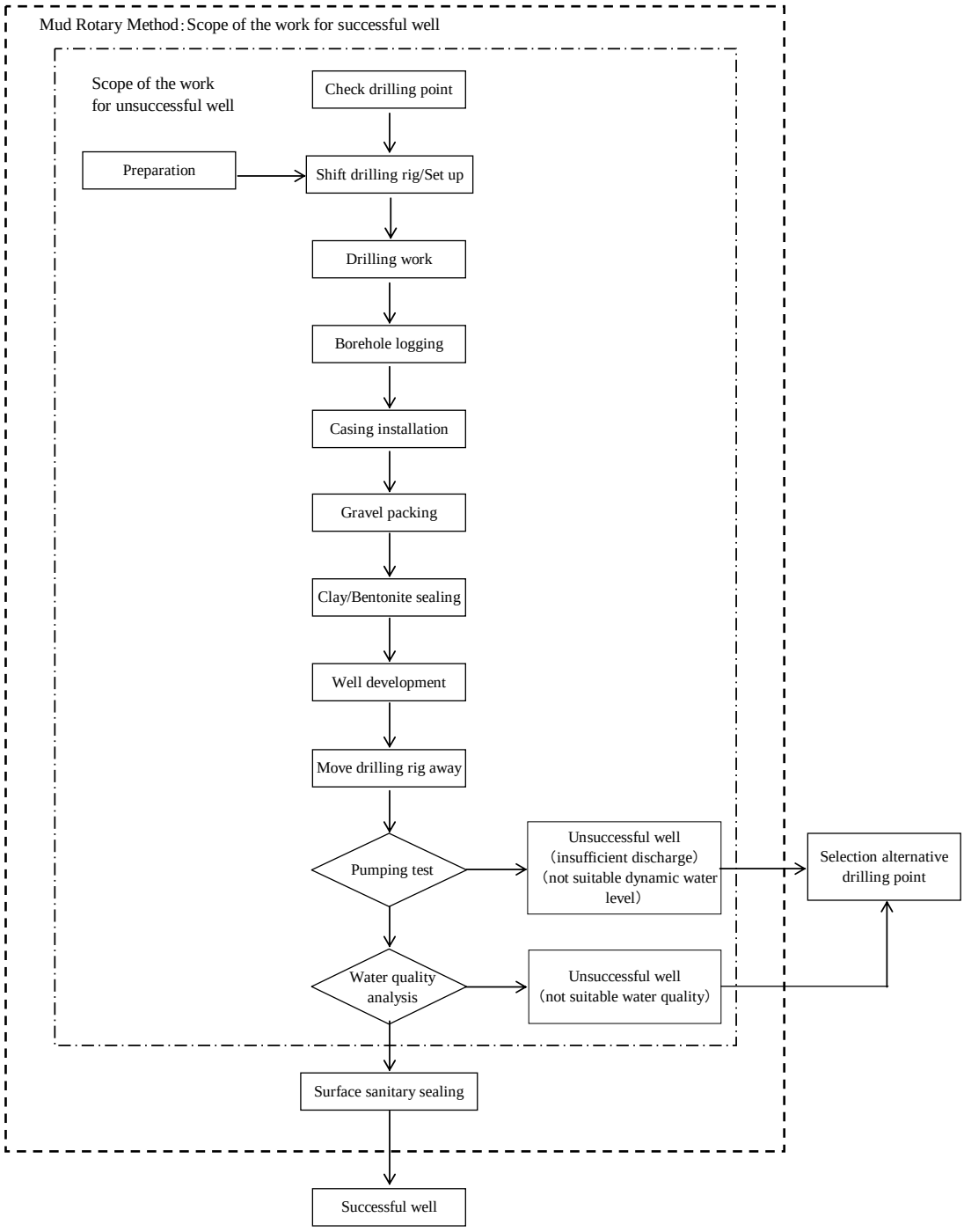


Figure 2-4: Flow chart for well drilling by Mud Rotary Method

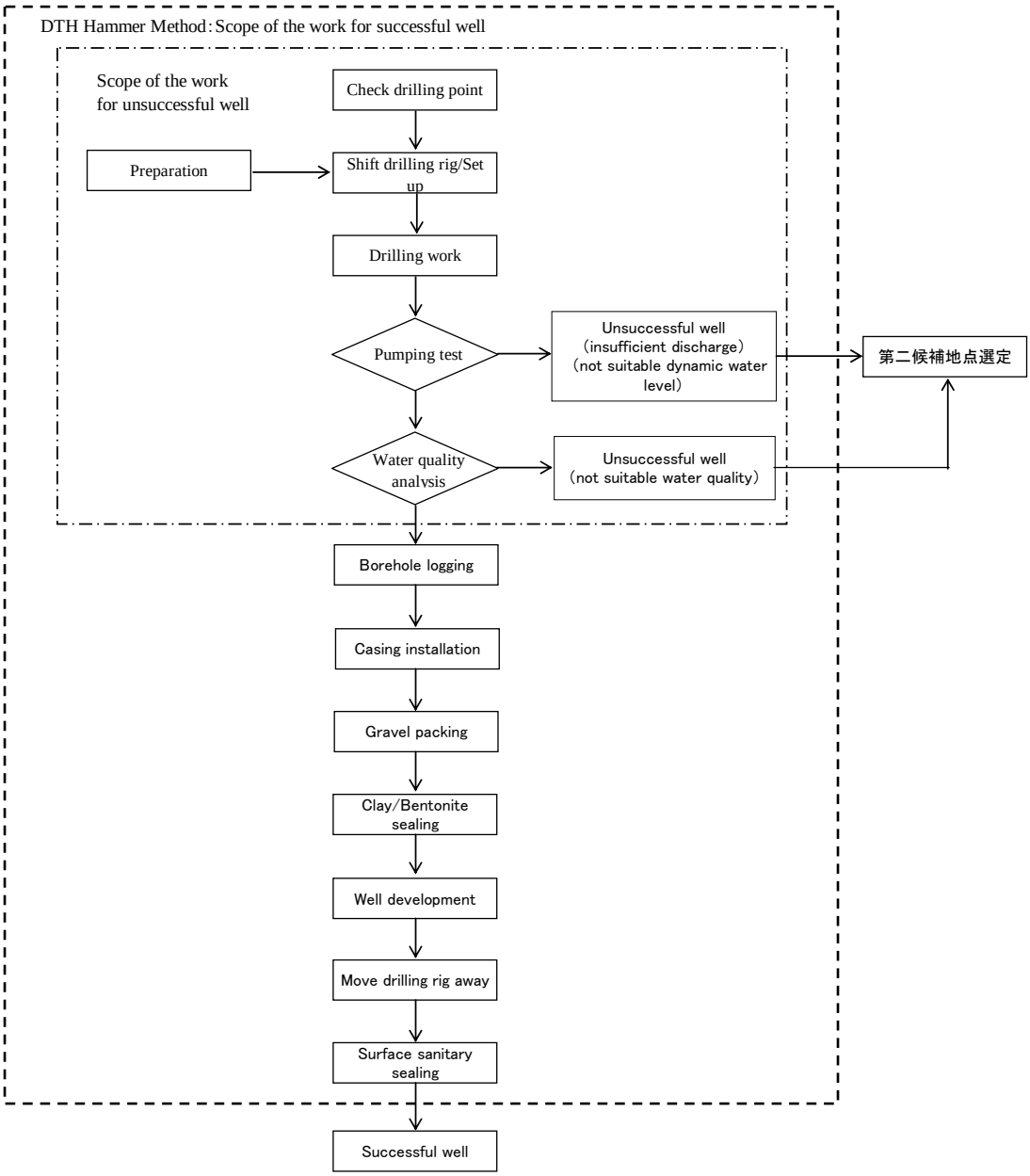


Figure 2-5: Flow chart for well drilling by DTH Hammer Method

10) Treatment of Failed Well

Table 2-22: Treatment of Failed Well

Item	Treatment
Treatment of Failed Wells	Backfilling after filling with sand, hydraulic filling and compacting
Maximum drilling number per one site (Gote)	A maximum of 2 wells drilled per site. If both wells fail, an alternative site shall be considered.

Candidate Villages (Alternative Drilling Site)	Candidate villages shall be from the top 15 sites selected in the Basic Design Study (see table below).

Table 2-23 blow shows the additional candidate villages. The precedence of the candidate villages is according to the priority in the Table 2-23.

If the drilling work at all 15 of the additional candidate villages are fails, other sites that were selected as next in priority in the Basic Design Study will be selected.

Table 2-23: Additional Candidate Villages

Priority	PJ ID	Woreda	Tabia	Kushet (village)	Gote (site)	2015 Supply pop.	Facility Type
1	JKA020	Kilte Awlaelo	Gemade	Tsaedanaele	Emhabi	476	Level 1
2	JKA002	Kilte Awlaelo	Mai quiha	Maidaero	Maakedi	439	Level 1
3	JHW018	Hawzen	Meztey	Meztey	-	549	Level 1
4	JHW012	Hawzen	Simret	Adibeles	-	1,483	Level 1
5	JTA010	Tanqua Abergele	Siye	Gomenge	Gomenge	470	Level 1
6	JKT015	Kola Temben	Debregenet	Debrehafash	Deda	390	Level 1
7	JAL016	Alamata	Selam bikalsi	Gendagaro	Gendagaro	528	Level 1
8	JHW020	Hintalo Wajirat	Waza Adiawena	Waza	Keyh hamed	366	Level 1
9	JHW019	Hintalo Wajirat	Waza Adiawena	Gerawa	Nazgi	610	Level 1
10	JKT018	Kola Temben	Guya	Dansemere	Dansemere	390	Level 1
11	JDT002	Degua Temben	Mahiberesilase	Mahibere mereb	Adinefti	390	Level 1
12	JKA011	Kilte Awlaelo	Awolo	Adibtsiat	Adibtsiat	354	Level 1
13	JKA006	Kilte Awlaelo	Aynalem	Adiwerema	Adiwerema	1,464	Level 1
14	JSS016	Seharti Samre	Adis Alem	Hantebat	Hantebat	366	Level 1
15	JTA004	Tanqua Abergele	Felegehiwot	Misaza	Misaza	732	Level 1

(3) Policy for Water Supply Facility Design

The policy for Level 1 and Level 2 designs are, in principal, in accordance with the Technical Design Standard by Tigray Region.

Level 1 Facilities (with hand pump)

The policy for the design of water supply facility with hand pump is shown in the table below.

Table 2-24: Project Conditions of Facilities with Hand Pump

Item		Criteria
Unit for water source design		15L/person/day
Population for supply design		400 persons per day/well
Hand Pump operation time		8.5 hours per day
Borehole Depth (estimate)	(average)	92m
	(maximum)	150m
Borehole drilling diameter		6-1/2"to 8-1/2"
Casing and screen diameter		4"
Hand pump		Afridev type
Hand pump yield capacity		12 to 20 L per minute
Structure surrounding well		Pump foundation, apron, drainage ditch
Livestock trough		Outside project design
Fence surrounding well		Responsibility of users

Source: Tigray Region Technical Design Standard and Survey by Basic Design Study

New and Rehabilitation Water Supply Facilities which accompany Pipeline Network

The following table shows the principal conditions among those which were confirmed through discussion with TWRMEB.

Table 2-25: Design and Project Conditions

Item			Design/Project Conditions
Planned Daily Average Supply	Effective Amount	Domestic use	15 L/person/day
		Schools	8 L/person/day
		Medical Clinics	25 L/person/day
		Churches	15 L/person/day
		Mosques	15 L/person/day
	Unaccounted for Water		20% of the above effective amount
Planned Daily Max. Supply			1.2 times the planned daily average supply
Planned Peak Hourly Supply			2.4 times the planned daily max. supply
Effective Head in Distribution Pipes			Effective head of about 5m at water point
Operation Time of submersible pump			In principle 7 hours
Operation Time of Public Taps			3 hours each in the morning and afternoon and 4 hours in the evening for a total of 10 hours.
Capacity of Service Reservoir			Allowance for 40% of daily max. supply in consideration of tap operation hours
Hydraulic Calculation Method for Water Pipelines			Hazen-Williams formula
Distribution pipes			In consideration with a period (15 years) of durability
Coefficient of velocity used for above calculation			C value: 110 (DIP and GS)

Source: Tigray Province Technical Design Standard and Survey by Basic Design Study

(4) Conditions for Well Design

The supply method is designed so that water is delivered from the borehole using a submersible pump and taken to the distribution reservoir. Nonetheless, in some of the facilities (Raya Azebo

district: Hadealga site), judging from the location, shape of the site and terrain conditions, it won't be possible to send water directly to the one of the two distribution reservoirs, and thus a booster pump will be used.

However, the method of distribution will use the flow of gravity in order to economize maintenance costs and undertake sustainable operations. The figure below outlines the concept for a Level 2 facility.

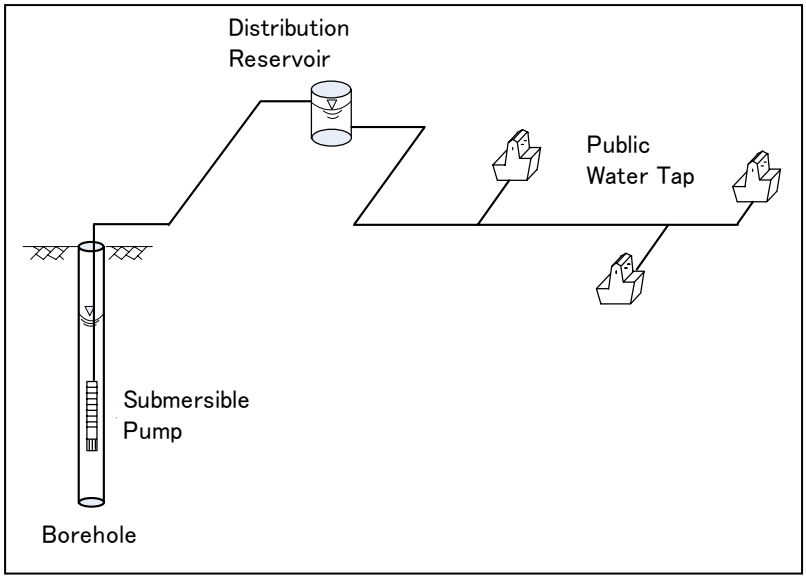


Figure 2-6: Conceptual Illustration of Water Supply Facility (No. 1)

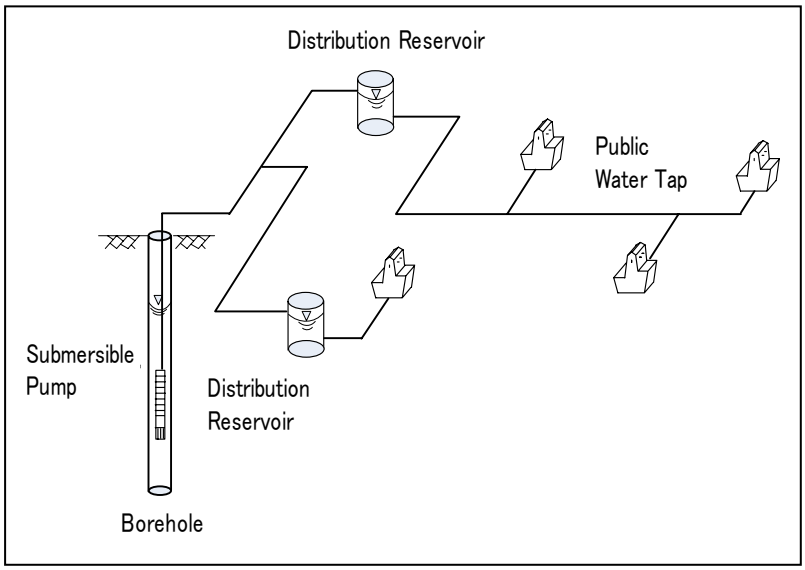


Figure 2-7: Conceptual Illustration of Water Supply Facility (No. 2)

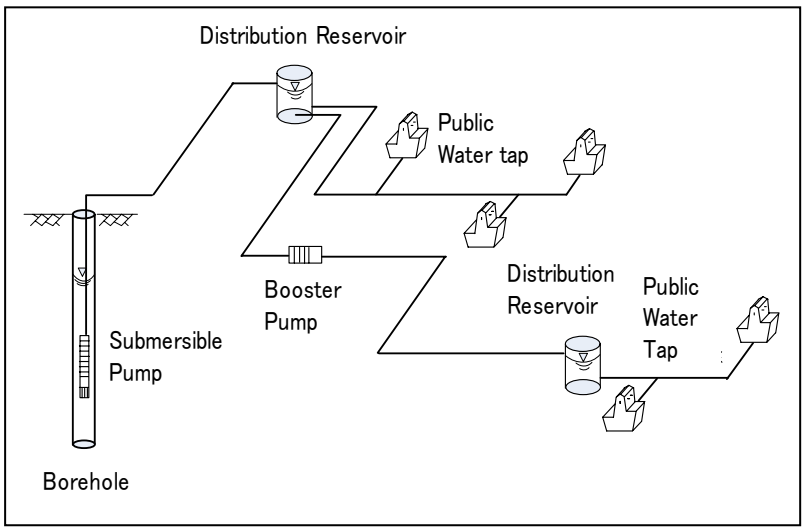


Figure 2-8: Conceptual Illustration of Water Supply Facility (No. 3)

Type No. 1 delivers water from the borehole with a submersible pump to the distribution reservoir, then by the force of gravity the water is distributed to one or multiple locations. The target facilities for type No. 1 are, as shown in Table 2-26, are new facilities in Raya Azebo district excluding No. 3 site (the Hadealga site and Keyih tekli site) and No. 6 site (Dodota site) for a total of 7 facilities, and an additional 3 facilities targeted for rehabilitation sites.

There is one site targeted for type No. 2, but because it is somewhat disjointed, the system has been divided into two distribution zones. Both zones draw water from the borehole which is sent to the respective reservoirs, where water is distributed by gravity to multiple public taps. The only target site for type No. 2 is Raya Azebo district No. 6 site (the Dodota site).

For type No. 3, the terrain conditions are such that it extends into two target sites and has been divided into two distribution zones. Because of that, it delivers water from the borehole using a submerged pump temporarily to reservoir of the Hadealga site, and from there using a booster pump, distributes water to the Keyih tekli site reservoir. Type No. 3 is only targeted for Raya Azebo district No. 4 site (the Hadealga site and Keyih tekli site).

(5) Facility Components

1) Hand Pump Water Facilities

a. Hand pump

Afridev type pumps (max. lift 45m) will be employed. Further, the length of the lift pipe was set at maximum pump capacity of 45m, taking into consideration the drop in water level in the dry season.

b. Platform

■ A concrete platform will be used, as it is already widespread in the Tigray Region. Furthermore, for the wells with hand pumps which produce a low yield and for which the general purpose is designated as drinking water, a policy was made not to establish a trough

for domestic animals.

- With the aim to maintain sanitary conditions around the pump, protective measures are established to prevent animals from trespassing, although this will require the self-supporting efforts of the residents.

2) Motor Pump Water Facilities

a. Borehole

The inner diameter in the final stage of completing the borehole will be 6 inches or 8 inches, according to specifications of the motorized submersible pump.

b. Submersible pump

Concerning the water source pump, the readiness of supply for the pump body and spare parts in the Tigray Region often decide whether to renew the Mono pumps, etc., of existing boreholes with motorized submersible pumps depending on the occasion. Therefore, in this project, in order to ensure the standardization of basic specifications and the manufacturer, it has been planned to use motorized submersible pumps. In order to conduct output yield control, a flow meter has been installed on the pump outflow side.

c. Booster Pump

The booster pump which supplies water to Keyih tekli employs a land pump that is used in parts of the Tigray Region. In addition, the operation method is a push style, making use of the distributing reservoir for Hadealga.

d. Distribution Reservoir

- Under the challenging geographical and social environment, attempting to decrease the construction risk and reduce costs for the durability of the structure, a stratified method is applied to sandwich concrete and masonry for above-ground distributing reservoirs at 25, 50 and 100m^3. This construction, when done on a small-scale (above-ground and 100m^3 or less), has become the standardized type in all of the Ethiopian regions.
- Concerning elevated types at or below 10m^3, designs call for a Roto[3] tank made of polyethylene, currently being used in many other regions with positive results. The steel used in existing elevated tanks has a tendency to corrode, causing notable leakage as a result, combined with the ready availability of the Roto tank, led to this decision.
- Furthermore, a flow meter will be installed on the outflow section of the distributing reservoir.

e. Public Taps

There are currently a variety of types of public water pumps in the Tigray Region. In this project, the convenience of the public taps structure has been set forth. Six faucet public taps have been

[3] Water tank made by polyethylene circulating generally in Ethiopia

planned in such a way that users should be able to shoulder the supply containers (poly- tank) from a reasonable height, and a designated spot will guarantee the ability to fill the drums. An apron and drain will be constructed around the public taps. Also, a water meter will be installed on the inlet side of the public taps.

f. Rising and Distribution Pipelines

- A gravity system is planned for the water supply system to decrease such maintenance expenses, and additionally, allow for a sustainable maintenance plan.
- In this plan, push on type ductile cast iron was selected due to its good workability and superior durability. However, regarding plumbing material with a diameter less than 50 mm, GS pipe is employed because ductile cast iron pipe is not generally produced at this size. The smallest diameter planned for the pipeline, taking into consideration future expansion plans, is one inch.
- Concerning laying the pipelines, at planned target areas where large vehicles do not pass, the minimum earth covering depth of 80cm (digging width: 60cm) is used based on technical design standards of the Tigray Region. Even where there is basement rock, in principle there are no plans for exposed pipes, and the basement rock will be chipped away to 20-30cm and, further, the distribution pipes will be covered with concrete. This policy was taken as damage to the pipelines due to such factors as human activity or animal movement will be avoided.

g. Wash-out Valves

The wash-out valve is installed in order for the smooth discharge of sludge, etc., in the pipeline sections where there are depression points.

h. Livestock troughs

Although future water demands are not estimated for supply for livestock, reservoir overflow and drain water from public taps will be available for livestock and a livestock trough and its surrounding pipes have been planned. There shall be one trough per facility.

i. Motorized equipment for Electrical submersible pumps

- In sites with existing commercial power supply in the vicinity of pump facilities, a policy is taken for the future supply of commercial electricity in order to reduce maintenance costs.

For other pump facilities, a generator will be used.

Table 2-26: Level 2 Facility Plan Summary

Fac. No.	Target Supply Region		BH (No.)		Water Main Pumps (No.)		Power Source		Rising Pipe		Machine House (No.)		Distribution Reservoir (m3)		Distribution Pipes		Public Taps (No.)
	Woleda	Site			Submersible	Booster	Type	Distance between Power Source and Pump House	Diameter (mm)	Pipe Length (m)			Ground	Elevated*1	Diameter (mm)	Pipe Length (m)	
1	Alamata	Gerjele town	1	To be drilled	1	0	Commercial	400	150	906	1	Control Panel House	50	0	40-75	391	3
2		Ula	1	To be drilled	1	0	Generator	-	75	717	1	Generator House	25	0	50-75	638	2
3	Raya Azebo	Hadealga	1	To be drilled	1	1	Commercial	1,400	100-150	6,140	2	Control Panel House Booster Pump House	50×2	0	40-75	3,016	5
		Keyih tekli						850									
4		Hirka Adialebachele Bachenrkatan	1	To be drilled	1	0	Commercial	50	150	8,456	1	Control Panel House	100	0	40-150	4,604	4
5		Fondel	1	To be drilled	1	0	Generator	-	75	2,136	1	Generator House	25	0	50	129	1
6		Dodota	1	Test drilling	1	0	Generator	-	40-100	2,384	1	Generator House	25	4	40-75	1,166	3
7		Hadishkign	1	Test drilling	1	0	Generator	-	75	681	1	Generator House	25	0	75	280	1
8		Gemed dadi	1	Test drilling	1	0	Generator	-	75	1,326	1	Generator House	25	0	40-75	1,410	2
9		Tachgubegala	1	To be drilled	1	0	Generator	-	75	771	1	Generator House	25	0	75	127	1
	Total		9		9	1				23,518	10					11,763	22

*1: Roto elevated tank

Table 2-27: Rehabilitation Facility Plan Summary

Fac. No.	Target Supply Region		BH (No.)		Water Main Pumps (No.)		Power Source		Rising Pipe		Machine House (No.)		Distribution Reservoir (m3)		Distribution Pipes		Public Taps (No.)
	Woleda	Site			Submersible	Booster	Type	Distance between Power Source and Pump House	Diameter (mm)	Pipe Length (m)			Ground	Elevated*1	Diameter (mm)	Pipe Length (m)	
10	Raya Azebo	Deletie	1	Test drilling	1	0	Generator	-	25	15	1	Generator House		4	40	200	1
11		Kepan	1	Test drilling	1	0	Generator	-	40	15	1	Generator House		10	40	50	1
12		Genete	1	Test drilling	1	0	Generator	-	25	15	1	Generator House		4	40	70	1
	合計		3		3	0				45	15					320	3

*1: Roto elevated tank

(6) Process of the Tender and Payment for Level 1 water supply facilities

1) Tender

On the occasion of the Tender, the quantity of the well construction for the Level 1 water supply facilities is specified in the tender document. The quantity of the boreholes that is assumed is shown below.

Table 2-28: Quantity of the borehole for the Level 1 Facility

Type	Quantity of successful well			Quantity of unsuccessful well			Total quantity
Success rate	77%	66%	Total	77%	66%	Total	
Type Ⅰ	17	-	17	6	-	6	23
Type Ⅱ	17	4	21	6	3	9	30
Type Ⅲ	7	37	44	3	20	23	67
Total	41	41	82	15	23	38	120

Table 2-29: Quantity of the pumping test and water quality analysis for Level 1 Facility

Item	Pumping test			Water quality analysis		
Type	Successful well	Unsuccessful well	Total	Successful well	Unsuccessful well	Total
Type Ⅰ	17	6	23	17	6	23
Type Ⅱ	21	9	30	21	9	30
Type Ⅲ	44	23	67	44	23	67
Total	82	38	120	82	38	120

Tender schedule by BQ is shown below.

The tender unit price for Type Ⅰ unsuccessful wells, which is the mud rotary method, includes casing costs; but the tender unit price for Type Ⅱ and Ⅲ unsuccessful wells, which are the DTH method, do not include casing costs.

Table 2-30: BQ for Level 1 Facility

Item	Unit	Qty	Unit price (JY)	Price (JY)
Successful well Type Ⅰ	nos.	17	Tender unit price A	Tender price A
Successful well Type Ⅱ	nos.	21	Tender unit price B	Tender price B
Successful well Type Ⅲ	nos.	44	Tender unit price C	Tender price C
Sub-total				
Unsuccessful well Type Ⅰ	nos.	6	Tender unit price D	Tender price D
Unsuccessful well Type Ⅱ	nos.	9	Tender unit price E	Tender price E
Unsuccessful well Type Ⅲ	nos.	23	Tender unit price F	Tender price F
Sub-total				
Pumping test	nos.	120	Tender unit price G	Tender price G
Water quality analysis	nos.	120	Tender unit price H	Tender price H
Sub-total				
Construction of Platform	nos.	82	Tender unit price I	Tender price I
Total				Total tender price

2) Completion of the work and payment

Completion of the work and payment for Level 1 water supply facilities were judged as follows.

① When the number of successful wells reaches 82 and the number of unsuccessful wells is less than 38, drilling work is continued until the balance of the total tender price becomes less than the cost of facilities for one site. The sites are selected from the upper rank of the additional candidate village list. In this case, the number of successful wells will be more than 82.

② When the number of unsuccessful wells exceeds 38 before the number of successful wells reaches 82, drillimg work is continued until the balance of the total tender price

becomes less than the cost of facilities for one site. In this case, number of the successful wells will be less than 82.

③ When the balance of the total tender price become less than the cost of facilities for one site, construction of level 1 water supply facility is judged to be completed.

④ The balance of the total tender price with the completion of work conducts a variation of the direct cost.

⑤ Variation is conducted by BQ of the Contract.

2-2-2-2 Equipment Plan

(1) Material Procurement

The following list shows the equipment that will be provided for this project.

Table 2-31: Equipment List

No.	Equipment Name	Content (Specifications, Measurements) Use	Qty
A1	Service Rig	Vehicle: 4×4 or 6×4 Hydraulic lift mast (Height = at least 9m) Hoisting Line (Lift weight: 5.0 tons or higher) Sand reel (Lift weight: 2.5 tons or higher) Water pump (discharge: 500L/min or more, Pressure: 1.96Mpa or more) Low Pressure Compressor (Air delivery: 8m3 or more, Pressure: 1.0Mpa or High elevation engine specifications	1
B1	Truck with Crane (for transp. pump test equipment)	Gross Vehicle Weight: 10 tons or higher Drive: 4×4 Truck bed: 4.0m, iron flooring Diesel engine Crane lift capacity: 3 ton (max.) High elevation engine specifications	1
B2	Submersible Pump	400L/min × 140mH: 1 unit Lifting pipe (above): 140m or more 200L/min × 80mH: 1 unit Lifting pump (above): 80m or more Pump control panel Well cover, Well bend pipe, etc.	1
B3	Generator	380V, 50Hz, 50KVA or more 3-phase 4-wire High elevation specifications	1
B4	V-Notch Wier	Max. Discharge: 450L/min	1
B5	Water Level Meter	Portable Measurement depth: 150m	1
B6	pH Meter	Portable Measurement range: 0 to 14	1
B7	Conductance/TDS Meter	Portable Measurement range: 0 to 19.9mS/cm or more (Conductance) Measurement range: 0 to 100mg/L or more (TDS)	1
B8	ORP Meter	Portable Measurement range: 0 to ±1999mV	1
B9	Turbidity Meter	Portable Measurement range: 0 to 800NTU or more	1
C1	Truck with Crane (for repair handpump wells)	Gross Vehicle Weight: 10 tons or higher Drive: 4×4 Truck bed: 4.0m, iron flooring Diesel engine Crane lift capacity: 3 ton (max.) High elevation engine specifications	2

(2) Necessity of Equipment and Basis for Quantity

1) Materials for well maintenance

A-1 Service Rig: 1 unit

The implementation organization TWREMB currently has one service rig used to repair existing wells, but the rig being an old model and the difficulty in obtaining spare parts has been an obstacle to conducting repair work. Thus, in order to promote continued service and maintenance, a request has been placed with the Government of Japan in order to renew the rig, although the content of that request was for a rig with extremely high capabilities of 12 inch well diameter and depth of 250 m to cover city water supply. Afterwards, discussions with the counterpart during the project resulted in agreement to request equipment that is capable of well repair for a maximum well diameter of 8 inches and depth of 150 m to cover the existing wells in villages and the test wells for this project. The selected equipment of a service rig for repair of maximum 8 inch diameter and 150 m depth was chosen based on prior experience.

- Vehicle Specifications

The service rig selected is one that has the necessary accessories with consideration to functionality and operating efficiency. The engine specifications are for high altitude (maximum altitude 2500m) with 4×4 or 6×4 drive.

- Well Repair Equipment

The repair method generally done in the Tigray Region are washing methods – bearings, brushing, and jetting – so equipment which covers these methods has been selected. Furthermore, the equipment was selected in consideration of the various diameters of existing wells; 4 inches, 6 inches and 8 inches.

- Compressor

Considerations for a well depth of 150 m are estimated for the following compressor capacity

Discharge pressure: 1Mpa or higher (10kgf/cm^2 or higher)

Air Discharge rate: 8.0m^3/min or higher

2) Pumping Test Materials

B1 Truck with Crane: 1 unit

This piece of equipment will mainly be used to transport equipment for well tests and to install submersible pumps. Also, when used together with the service rig,, it can be used to transport extra materials. Furthermore, it is not foreseen that well washing and pumping tests would be carried out on the same schedule, so the carrying capacity may be reduced (or reduce the number to be procured).

- Vehicle Specifications

For the carrying capacity, considerations were made for pumping test equipment with an overall

load of 3 tons or higher and vehicle bed length of 4 meters or longer with consideration to the lift pipes for submersible pumps.

Also, 4-wheel drive capability is selected because of poor road conditions in the rainy season.

- Crane Capability

The lifting capacity of the crane shall be able to handle the submersible pump for level 2 wells (140m X 400L/min) provided in this project, and the lift weight and operating radius of generators of 3 tons (operating radius 2.5m) or more.

B2 Submersible Pump: 2 units

A pumping test will be implemented after well washing is completed in order to assess well capability (specify the pump discharge). The quantity to be supplied takes into consideration both planned and existing wells in the Tigray Region, one for each Level 1 well and Level 2 well.

a) The type specified which corresponds with the Level 1 wells (4 inches) is for a depth of 80m and discharge of 100L/min with consideration to the pump discharge of the planned and existing wells, and the largest lift of the hand pump wells.

b) The type specified which corresponds to the Level 2 wells (6 and 8 inches) is for a depth of 140m and a maximum discharge of 400L/min with consideration to the water level and pump discharge of the existing wells and test wells.

B3 Generator: 1 unit

This has been planned for the power source for the above-mentioned submersible pumps. The specifications are for the necessary capacity (kVA) to start the above mentioned Level 2 submersible pumps.

B4 V-notch weir: 1 unit

This equipment is a measuring square to measure the discharge amount for pump tests. It is the easiest and most accurate instrument (method) to do so. The specifications are for 450L/min with consideration to the maximum discharge of the Level 2 well submersible pump.

B5 Water level meter: 1 unit

Groundwater levels will change with the season and furthermore over a span of several years due to seasonal changes, so this is an essential item for regular monitoring which is easy to carry. Specifications are for a height of 150m giving a 10 m allowance above the overall 140m of Level 2 submersible pumps mentioned above.

B6 pH meter: 1 unit

This portable instrument for water quality measurement is easy to operate and will be used to obtain the minimum required water quality data for the file when conducting a pumping test.

B7 Conductance/TDS meter: 1 unit

Electric Conductivity (EC) is a desirable water quality analysis item for on-site measurement because EC values fluctuate immediately after coming into contact with the atmosphere.

Specifications call for a meter which can measure 0~19.9ms/cm. TDS is something which measures the quantity of all dissolved substances, measuring 0~100mg/L. Also, a portable type is chosen for on-site usage.

B8 ORP meter: 1 unit

Oxidation Reduction Potential (ORP) shows the state of oxidation restoration of water quality, and is closely related to water quality items iron and arsenic, etc. It is desirable to take this measurement on-site since the values fluctuate immediately after being exposed to the atmosphere. This equipment, used for analysis of redox potential, has a general standard of measurement of 0~±1999mv. Also, a portable type is chosen for on-site usage.

B9 Turbidity meter: 1 unit

Water quality analysis for turbidity is best done on-site as the values will fluctuate immediately after being exposed to the atmosphere. This equipment, used for turbidity analysis, has a general specification to be able to measure 0~800NTU. Also, a portable type is chosen for on-site usage.

3) Operation and Transport Equipment: 2 Units

C1 Truck with Crane

This equipment is used primarily for the transportation, installation and lifting of hand pumps. In addition, it will be used to transport hand pumps for upgrade and supplemental parts to the north and central zone from the central maintenance workshop.

- Crane Capability

The operating radius shall be 5m with consideration to the outrigger extension for the platform width stipulated in the Tigray region technical standard. The lifting capacity will be 1 ton or higher in anticipation of the allowance for the hand pump lifting pipe (when H = 80 m). Furthermore, among the cranes for truck loading on the market, a crane with nominal lifting capacity of 2.9 tons will satisfy the above-mentioned matters, and thus is the same as the truck with crane designated for the pumping test (B1).

- Vehicle Specification

A 4-wheel drive vehicle that can carry the above-mentioned crane is selected. The overall load of the vehicle will be 10 tons or higher in order to transport hand pump equipment.

(3) Division of Principal Equipment Procurement

None of the equipment to be supplied in this plan is produced domestically in Ethiopia and, therefore, will be procured in Japan or a third country. The decision of what country the equipment will be purchased in will take into consideration quality assurance, reliable delivery and readiness of supply. The country in which the equipment will be procured is shown in the table below.

Table 2-32: Division of Equipment Procurement

Equipment	Japan	Third Country	Remarks
O&M Equipment			
Service Rig	○		
Drawdown Test Equipment			
Truck with crane	○		
Submersible pump set	○	○	Procure from Japan or EU country
Generator	○	○	Procure from Japan or EU country
V-shaped weir	○		
Water level meter	○		
pH meter	○		
Conductance/TDS meter	○		
ORP meter	○		
Turbidity meter	○		
Work/Transport Equipment			
Truck with crane	○		

2-2-3 Basic Design Drawing

The basic design drawings for this project are shown the pages that follow.

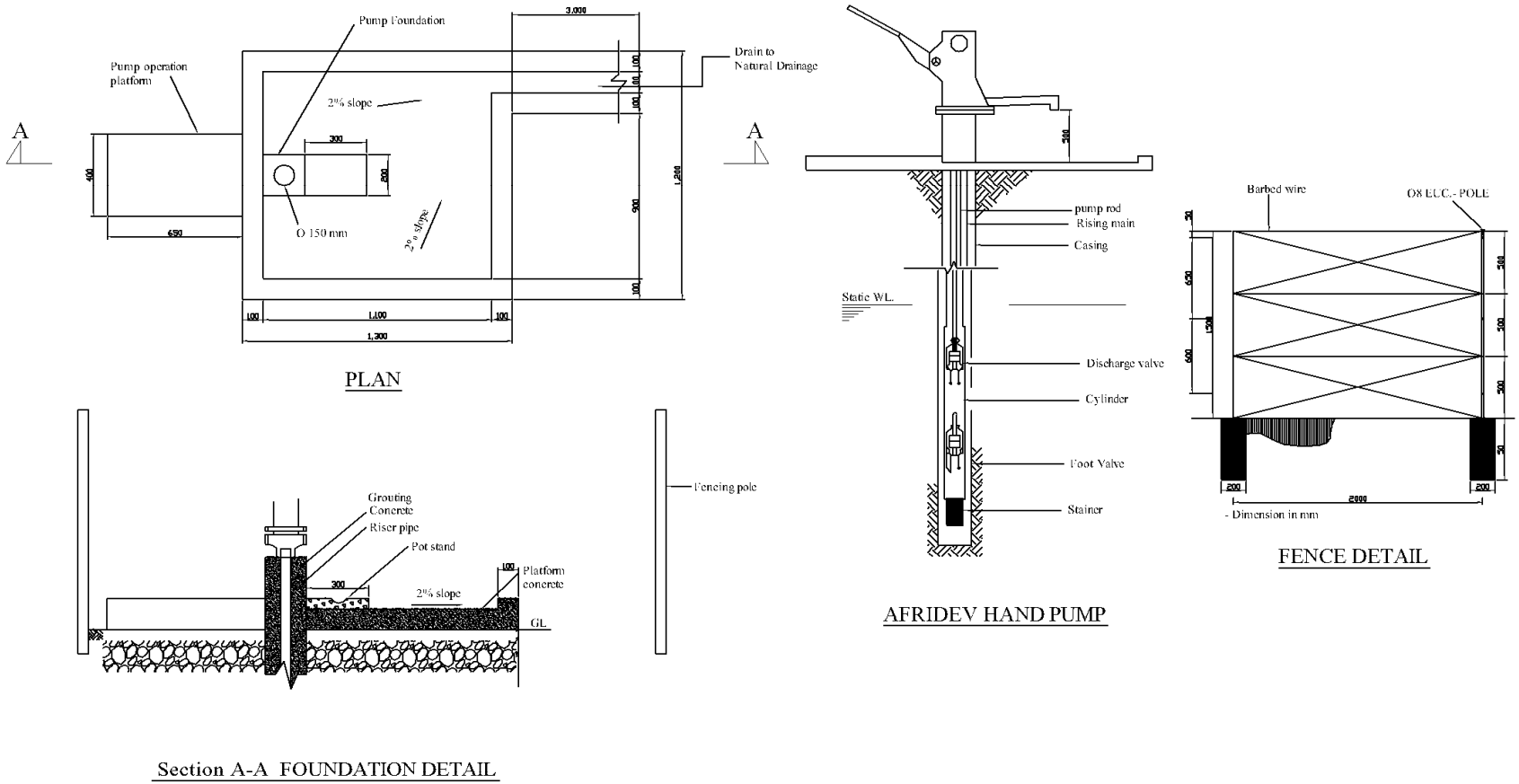


Figure 2-9: Borehole with Hand Pump

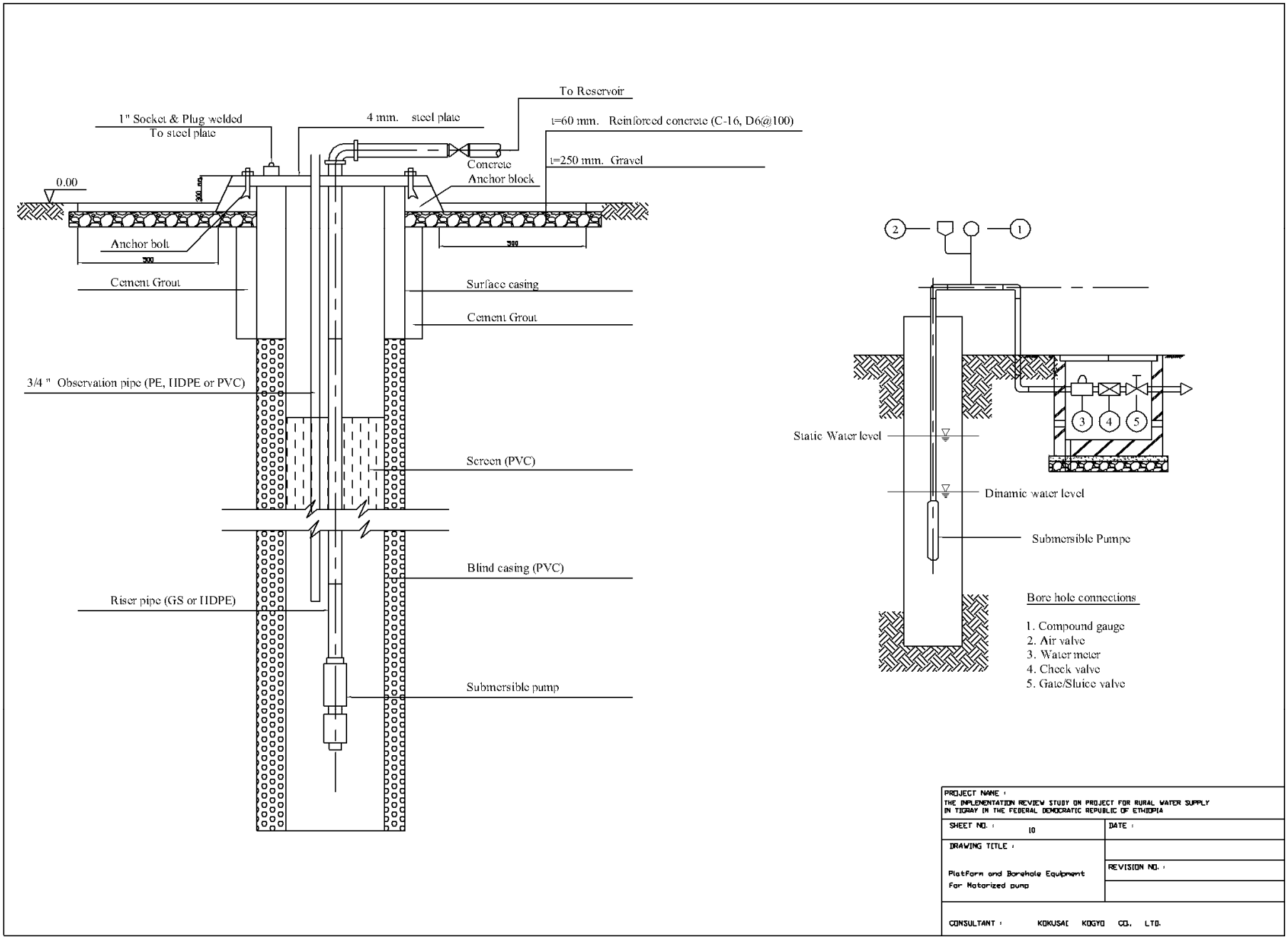


Figure 2-10: Borehole with submersible Pump

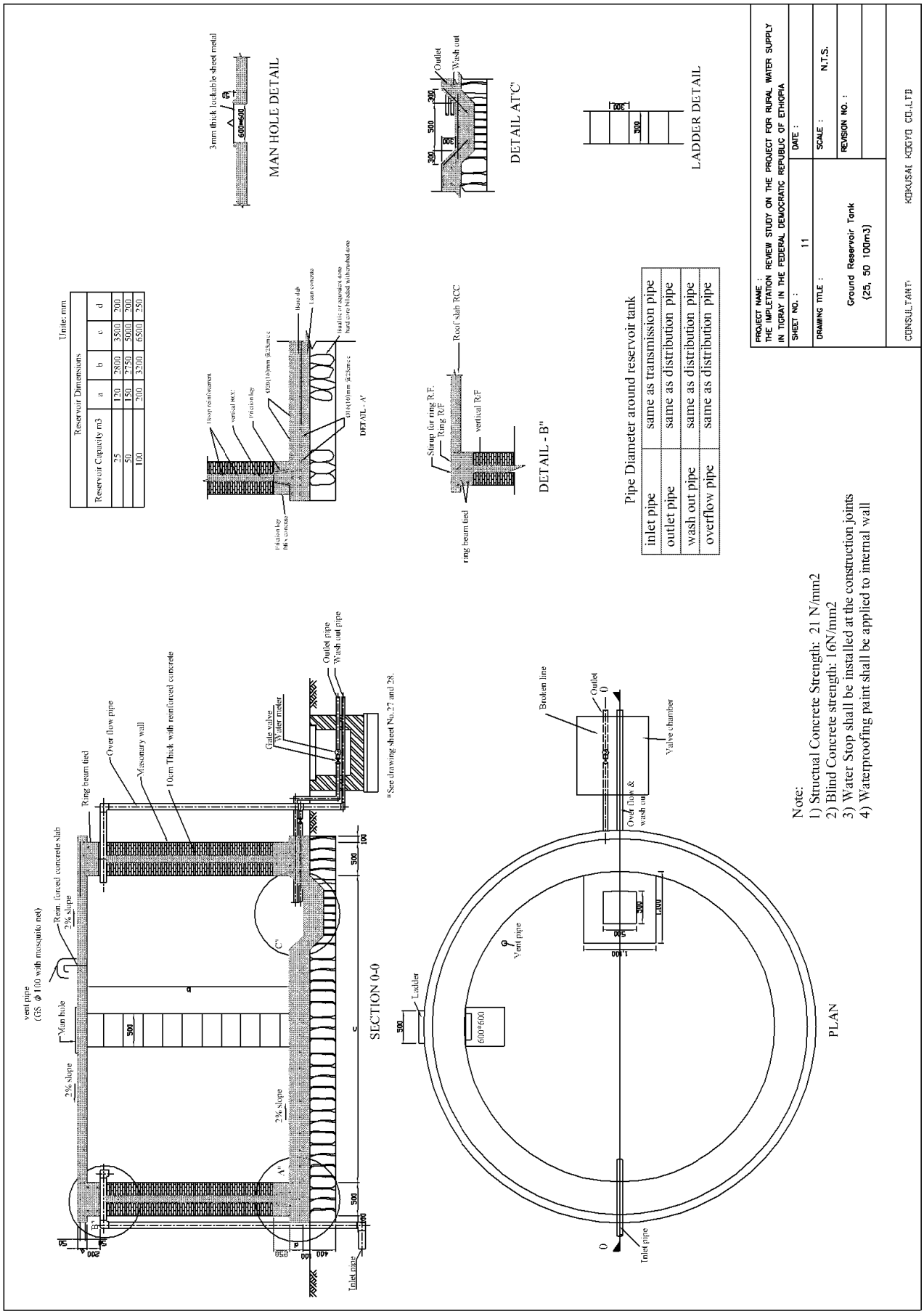


Figure 2-11: Circular Water Reservoir

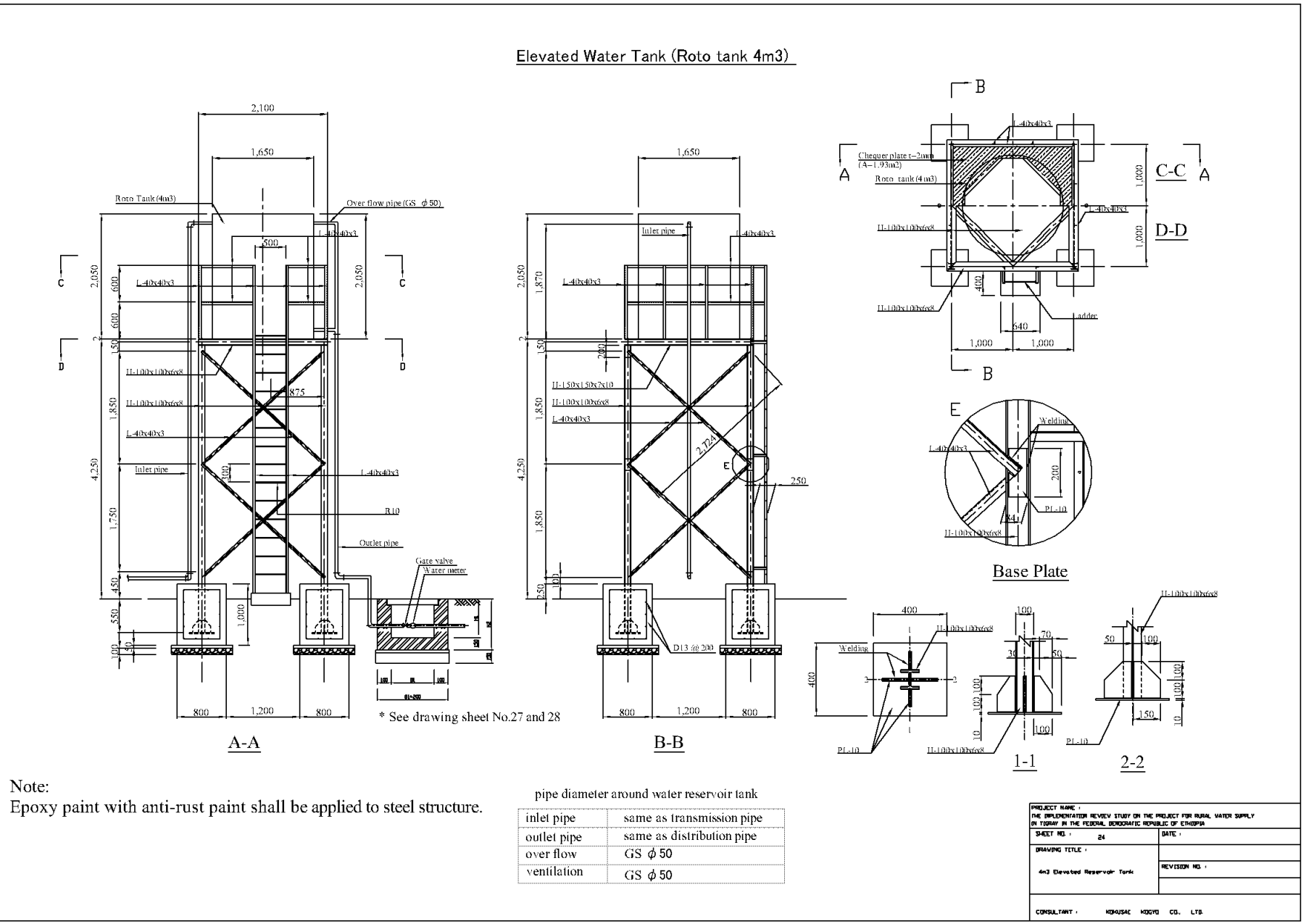


Figure 2-12: Elevated Water Tank (Roto tank 4m^3)

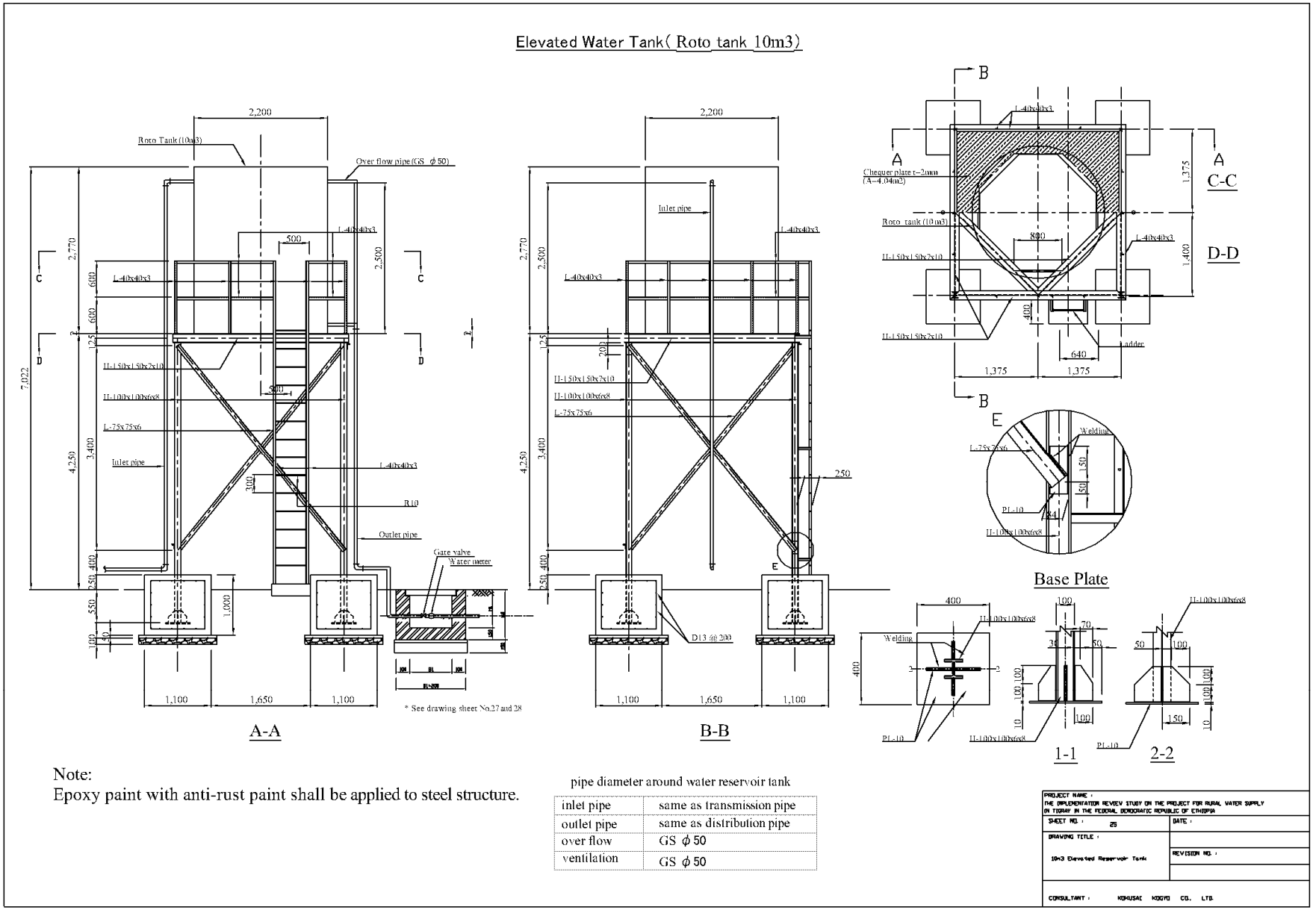


Figure 2-13: Elevated Water Tank (Roto tank 10m^3)

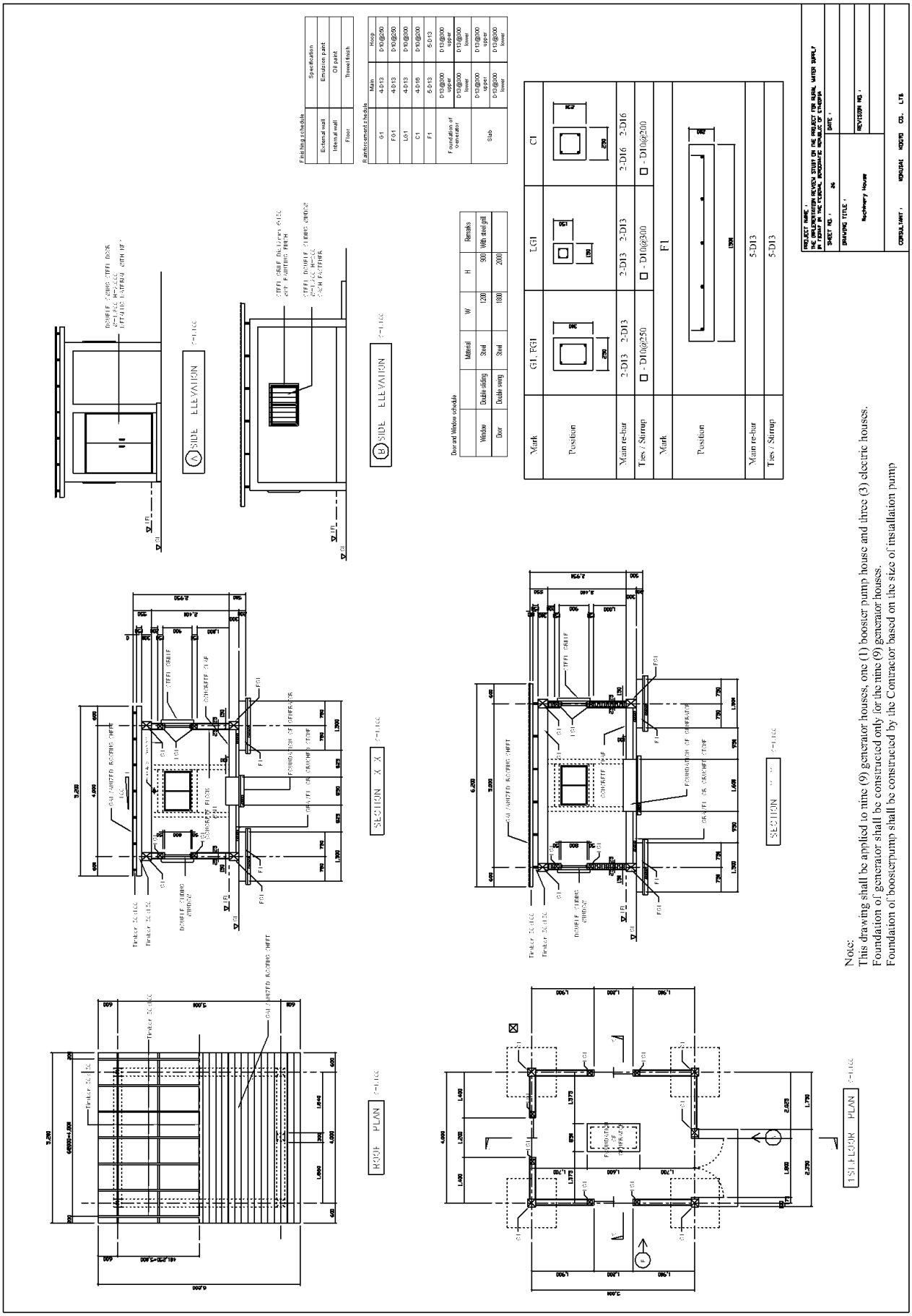


Figure 2-14: Generator (Surface Pump) House

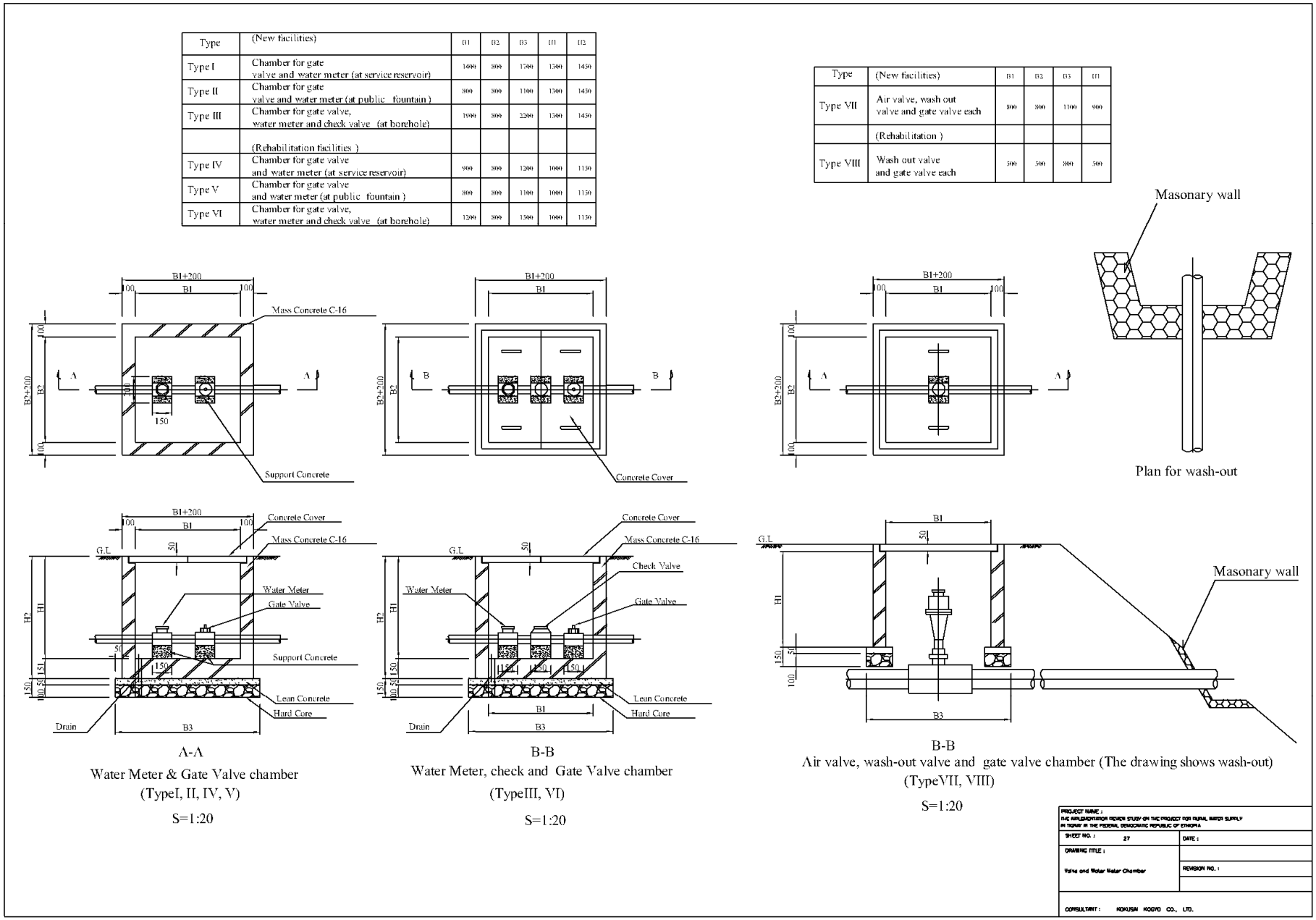


Figure 2-15: Chamber for Gate Valve, Air Valve, Check Valve, and Water Meter

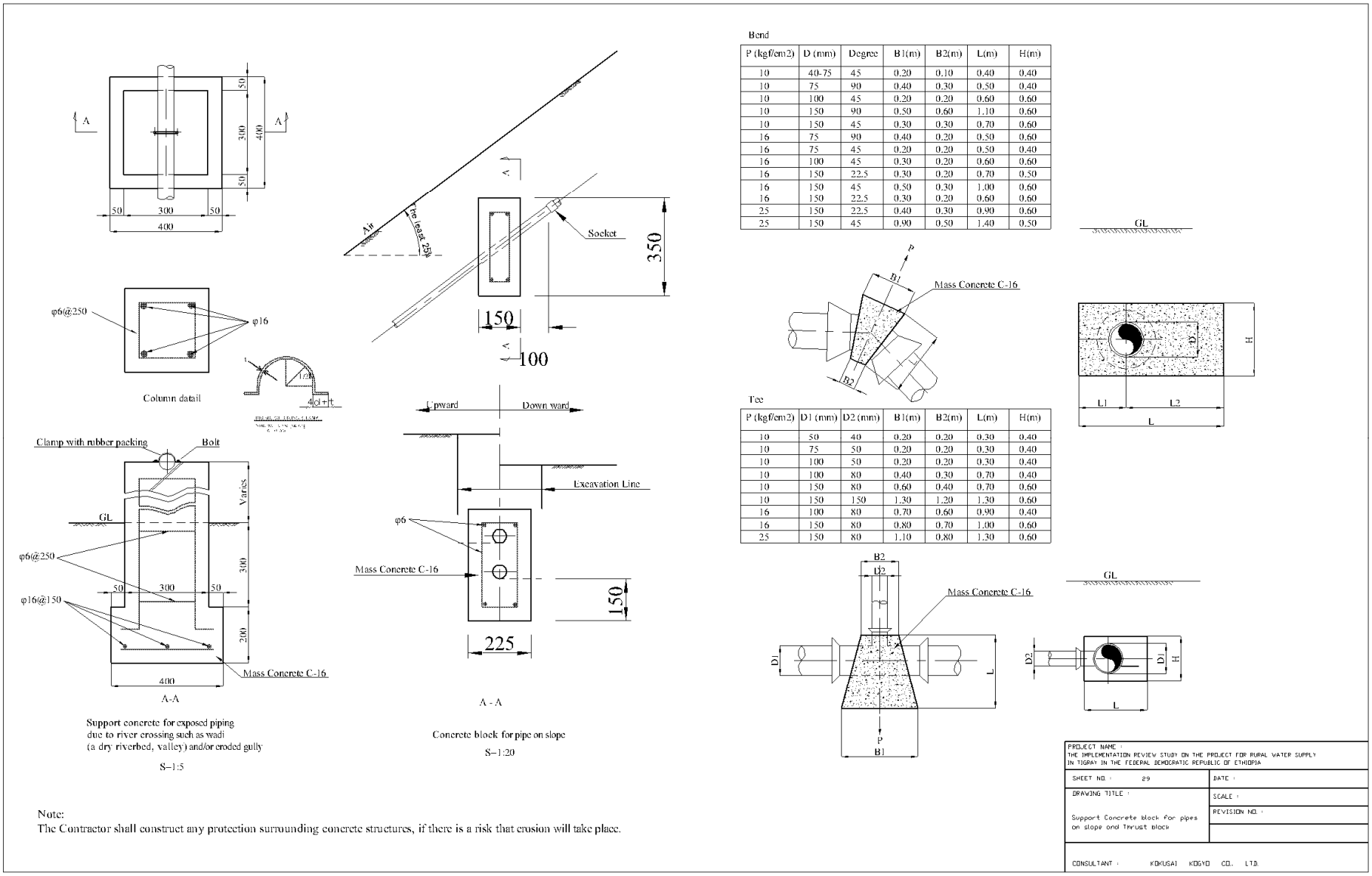
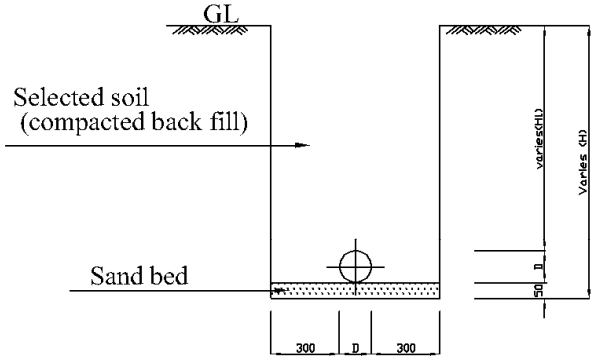


Figure 2-16: Support Concrete Block for Pipes on Slope and Thrust Block

Typical pipe trench cross section

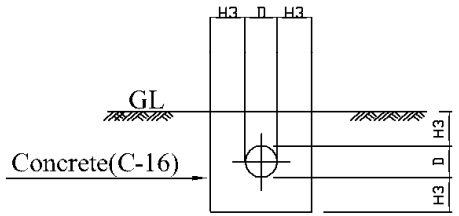


* D: pipe diameter
H: shown in drawings sheet No.37-75
H1: minimum pipe cover depth= 80cm

Typical pipe trench cross section (soil excavation)

Unit: mm

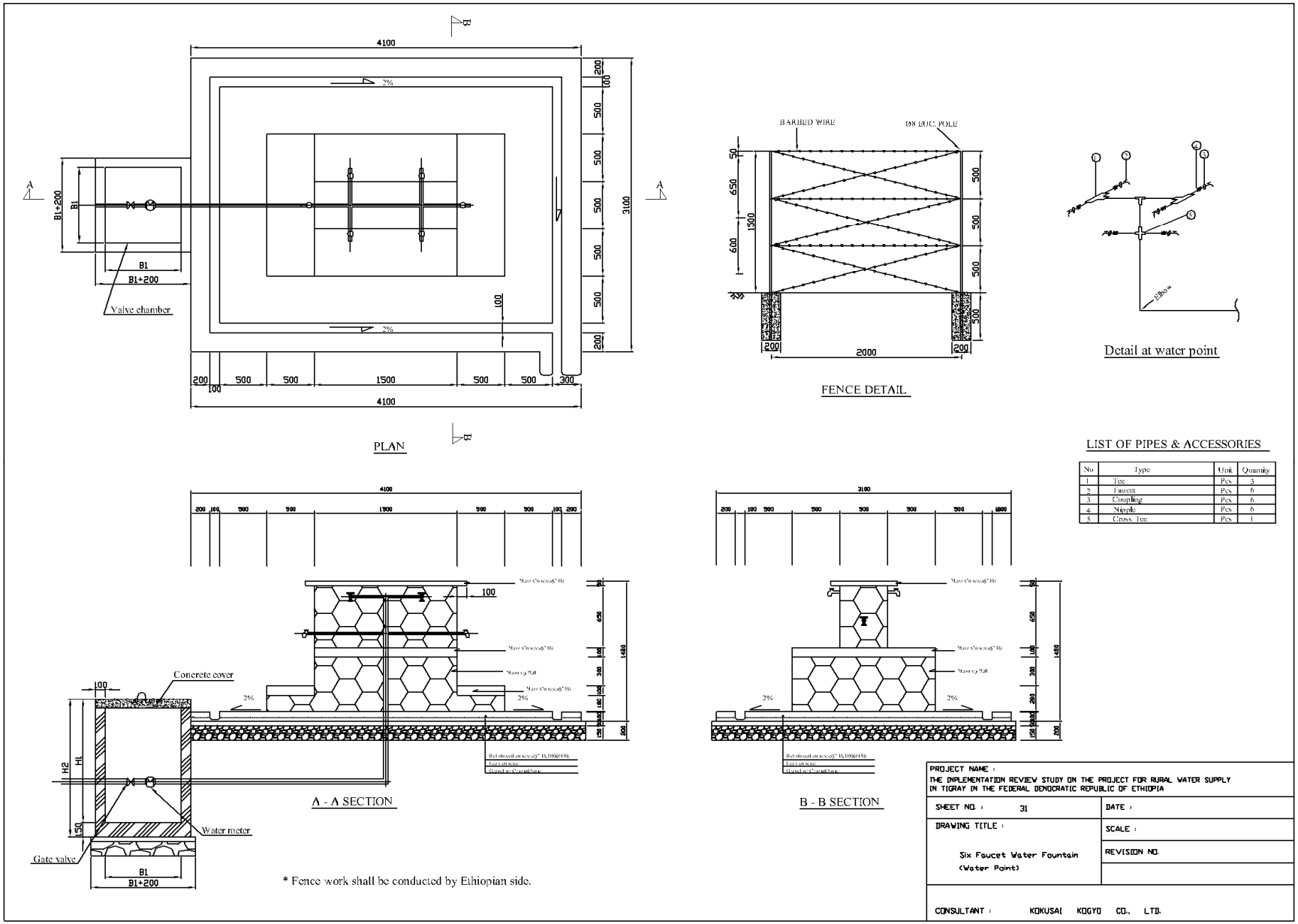
Pipe Diameter	φ150	φ100	φ80 (φ75)	φ50	φ40
D+2H3	500	400	300	250	250



Typical pipe trench cross section (rock excavation)

PROJECT NAME : THE IMPLEMENTATION REVIEW STUDY ON THE PROJECT FOR RURAL WATER SUPPLY IN TIGRAY IN THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA	
SHEET NO. : 30	DATE :
DRAWING TITLE : Typical Pipe Trench Cross Section For pipe laying	SCALE :
	REVISION NO. :
CONSULTANT : KOKUSAI KOGYO CO., LTD.	

Figure 2-17: Typical Section of Earth Work for Pipe laying



No	Type	Unit	Quantity
1	Tee	Pcs	3
2	Faucet	Pcs	6
3	Coupling	Pcs	6
4	Nipple	Pcs	6
5	Cross Tee	Pcs	1

Figure 2-18: Six Faucet Water Point

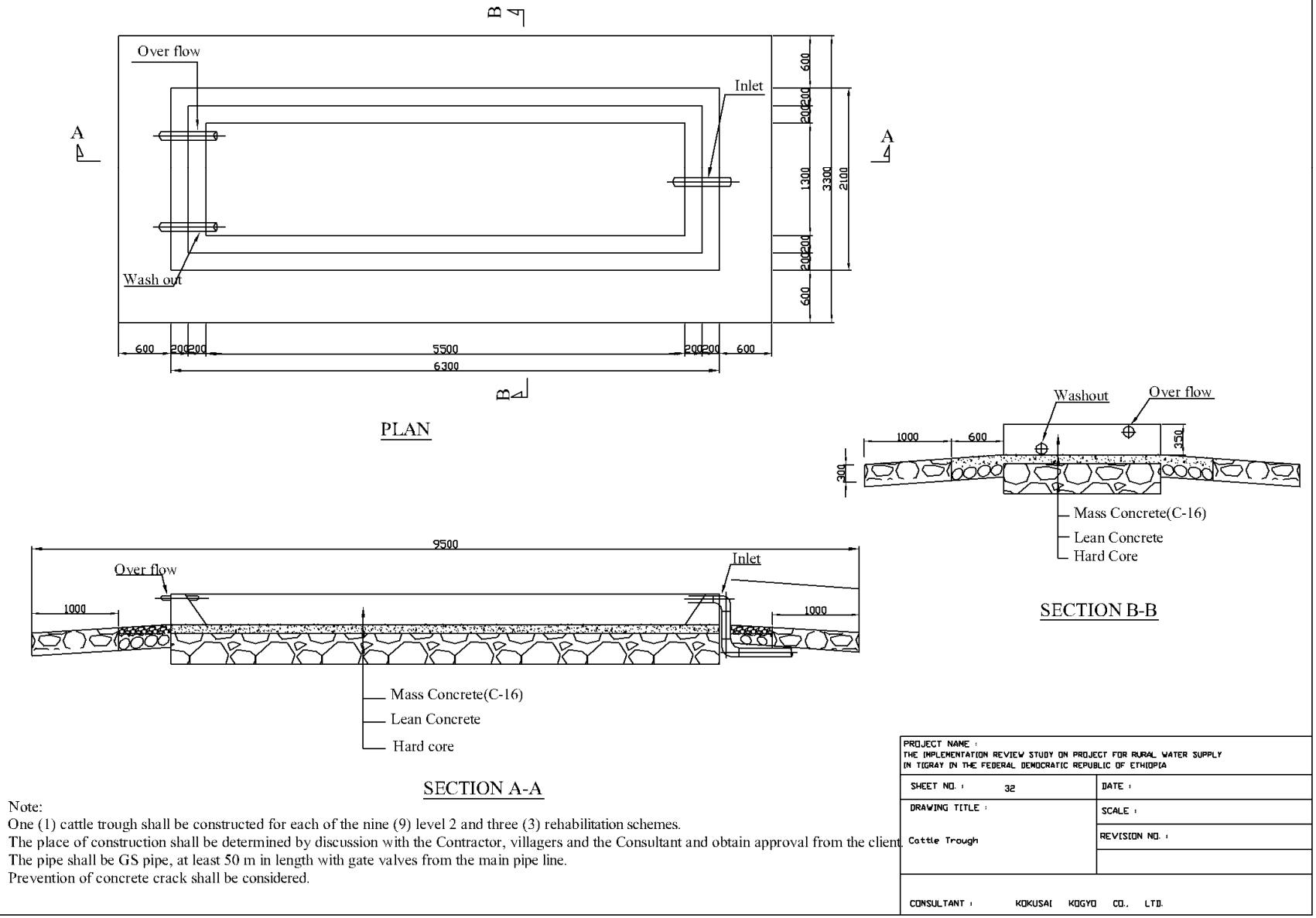


Figure 2-19: Cattle Trough

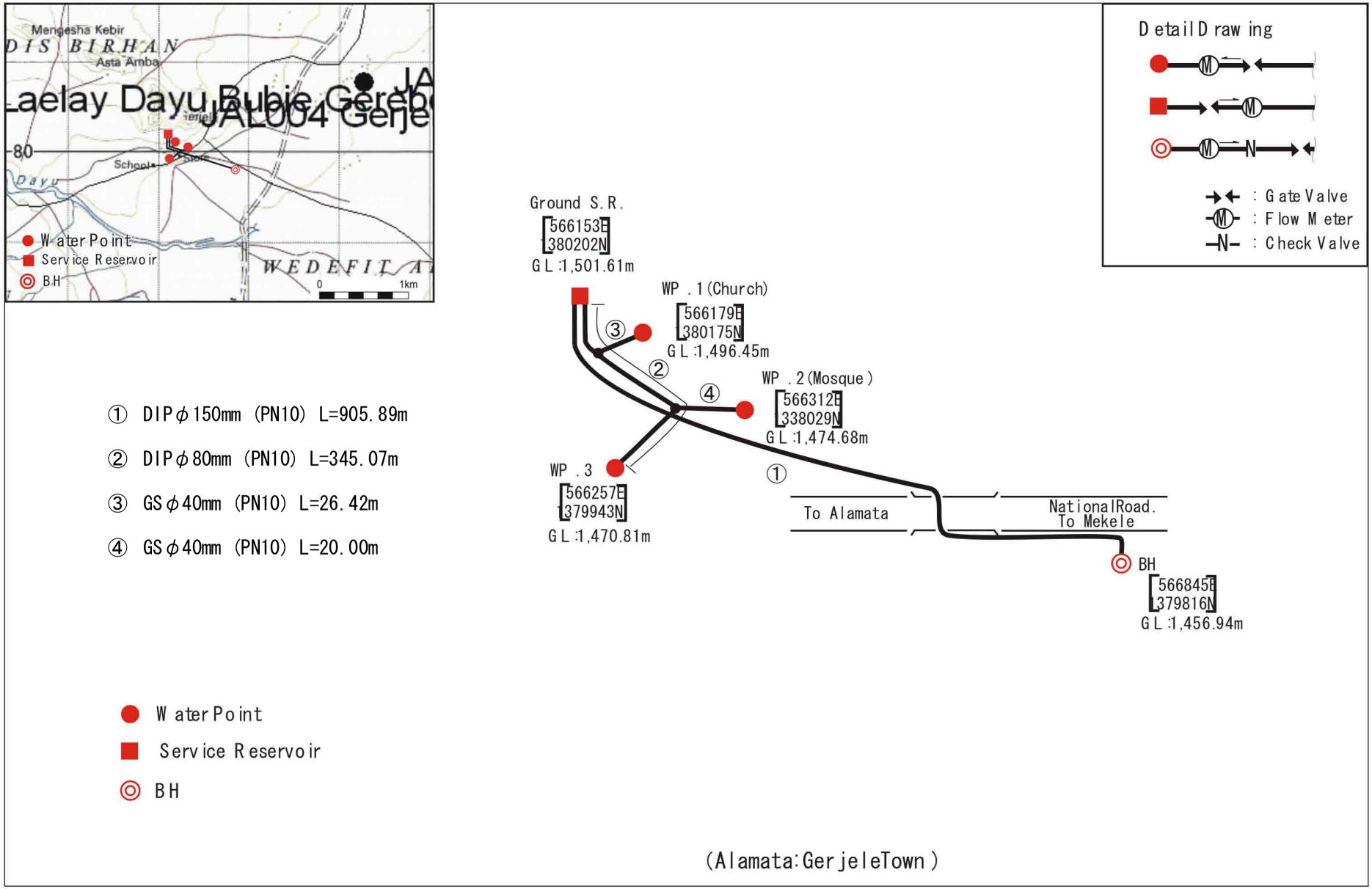


Figure 2-20: Layout for Water Supply Facility at Gerjele Town

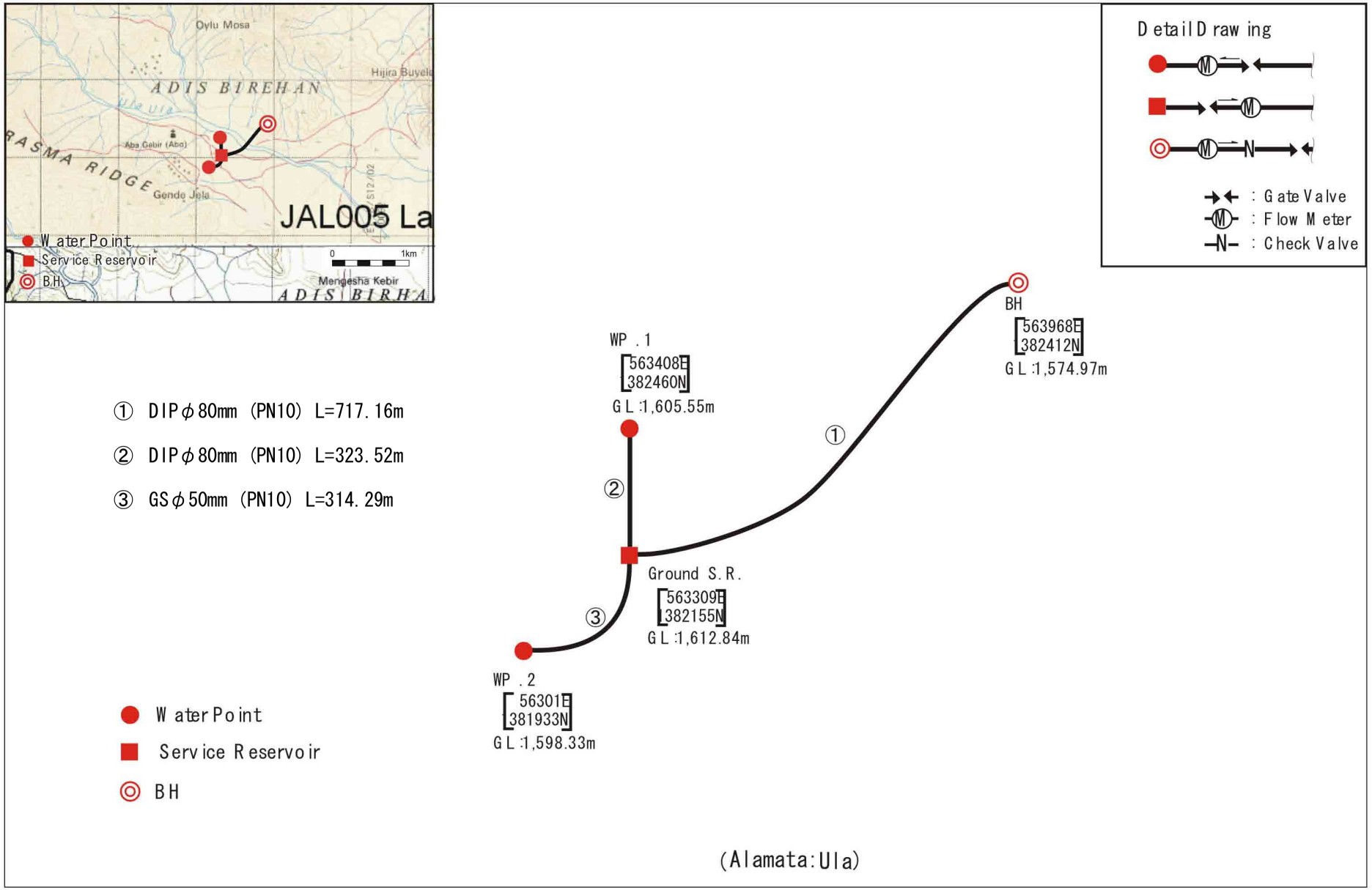


Figure 2-21: Layout for Water Supply Facility at Ula

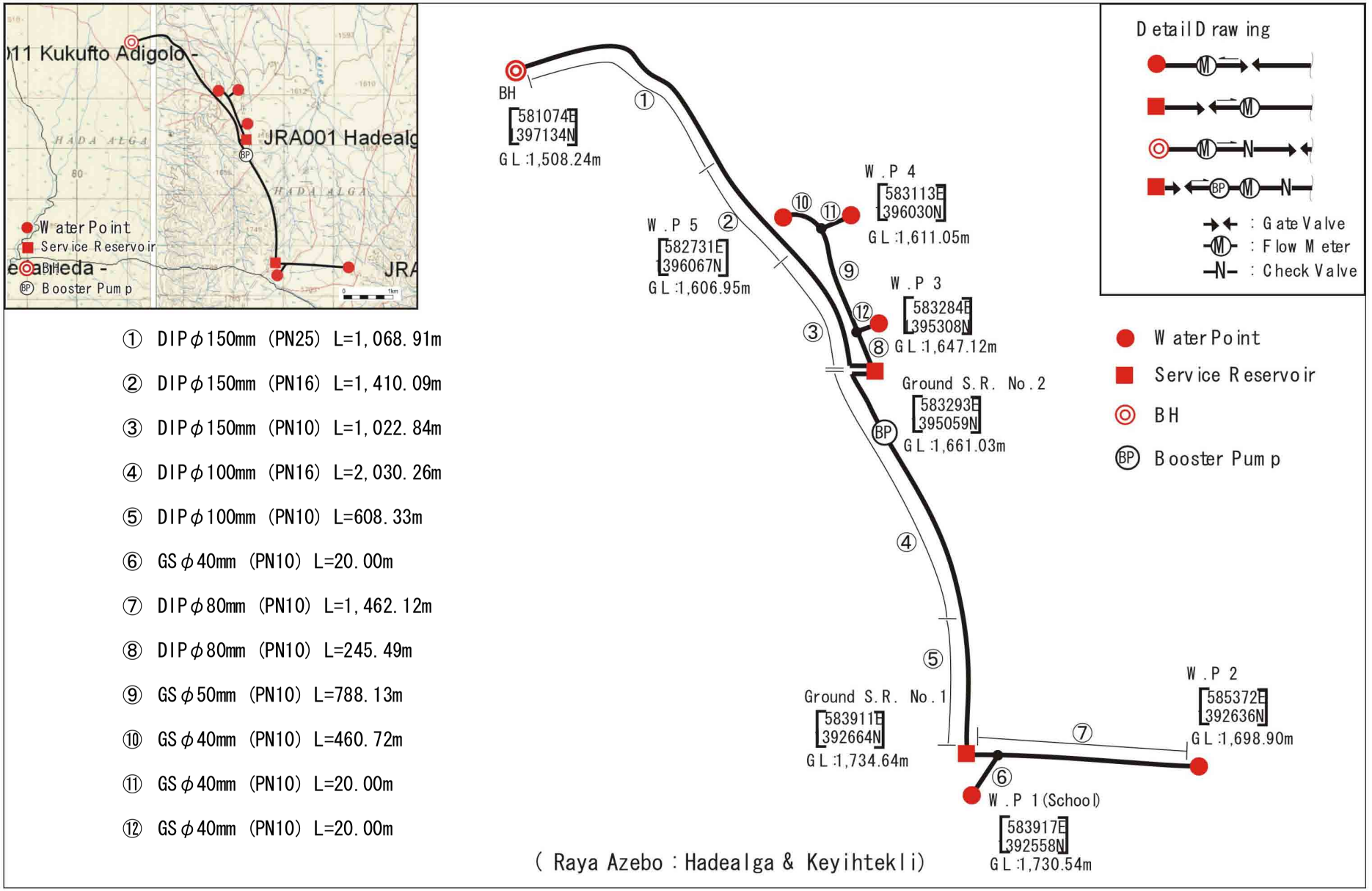


Figure 2-22: Layout for Water Supply Facility at Hadealga and Keyihtekli

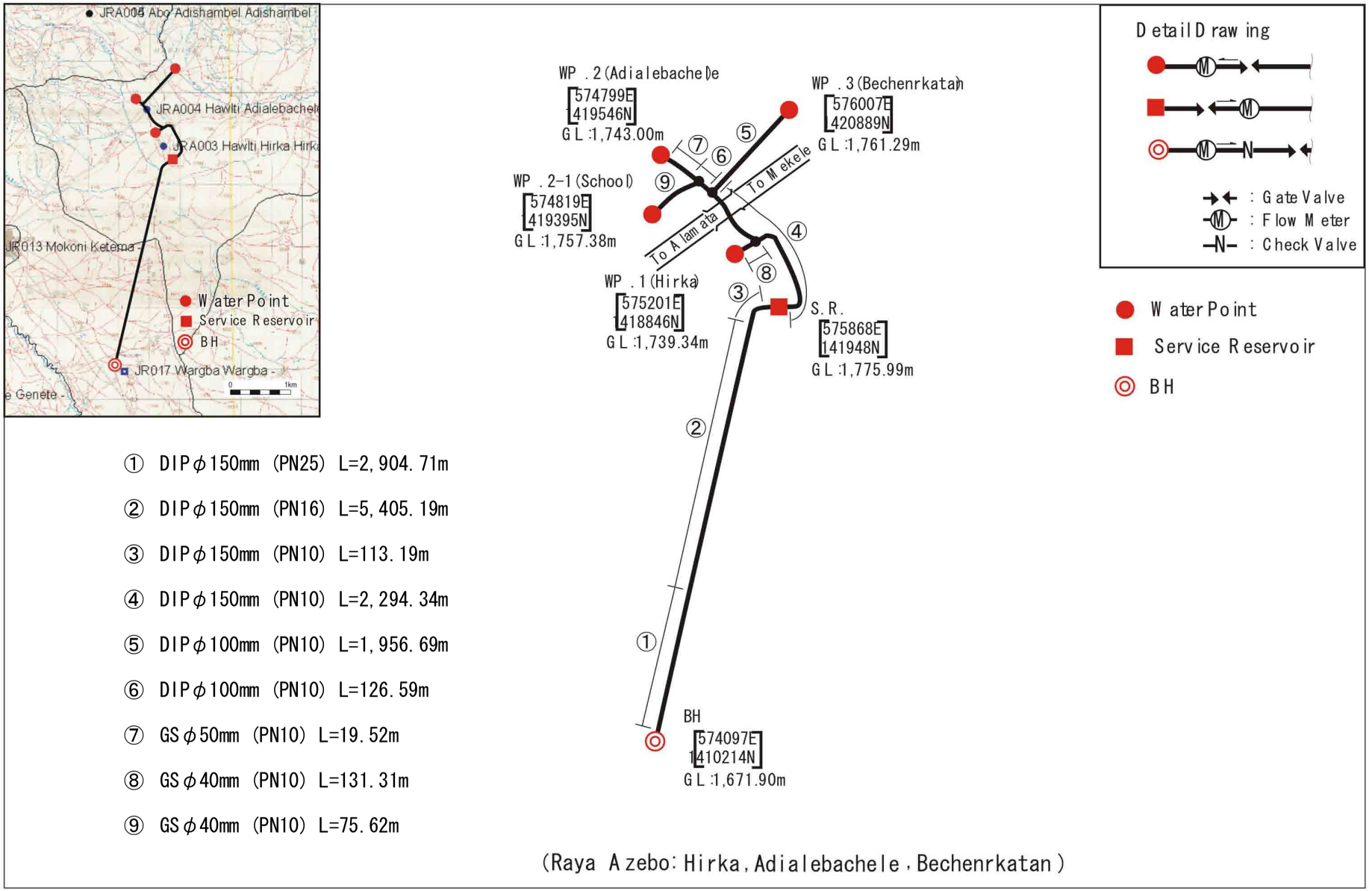


Figure 2-23: Layout for Water Supply Facility at Hirka and Adialebachele and Becherkatan

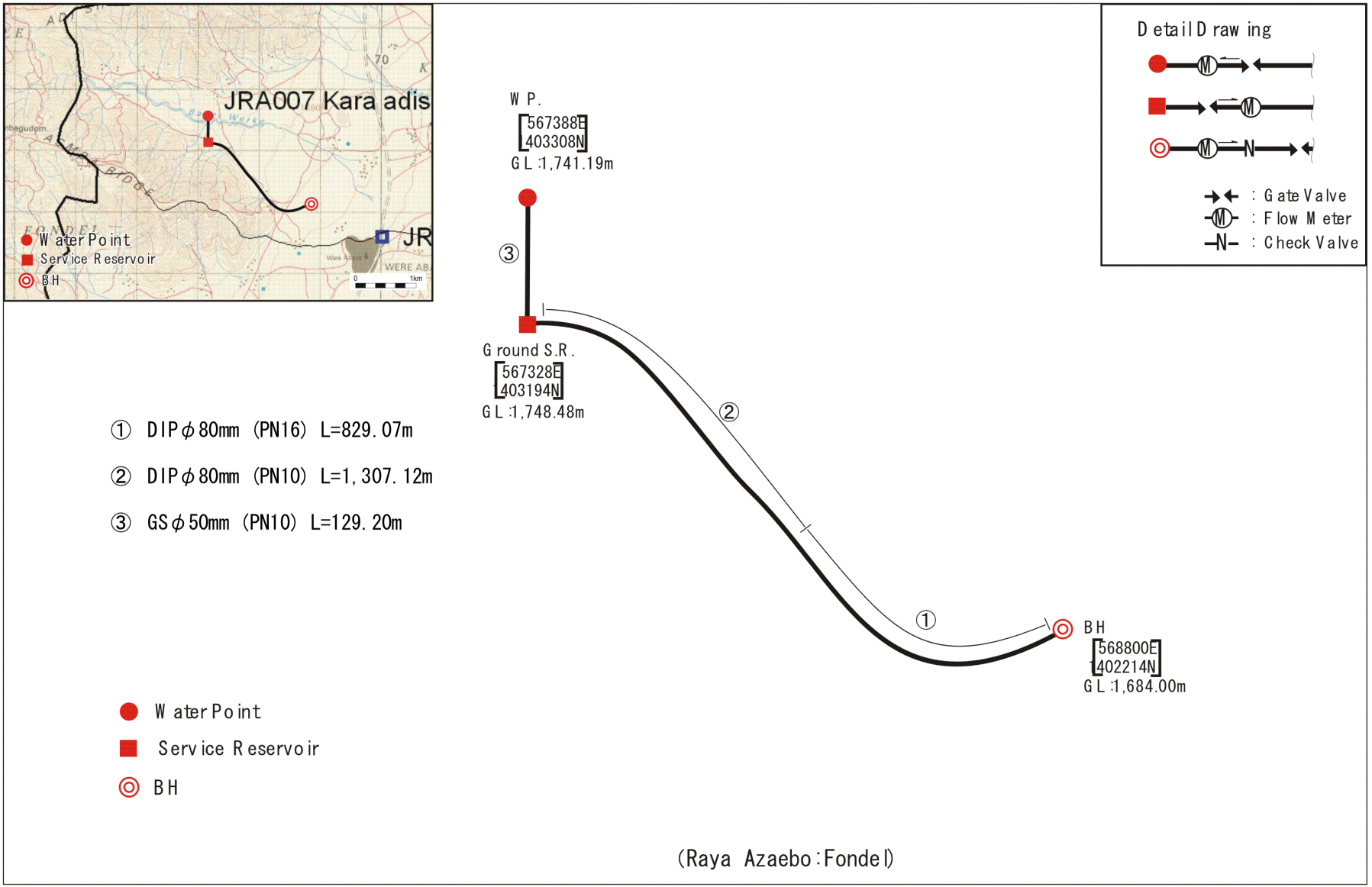


Figure 2-24: Layout for Water Supply Facility at Fondel

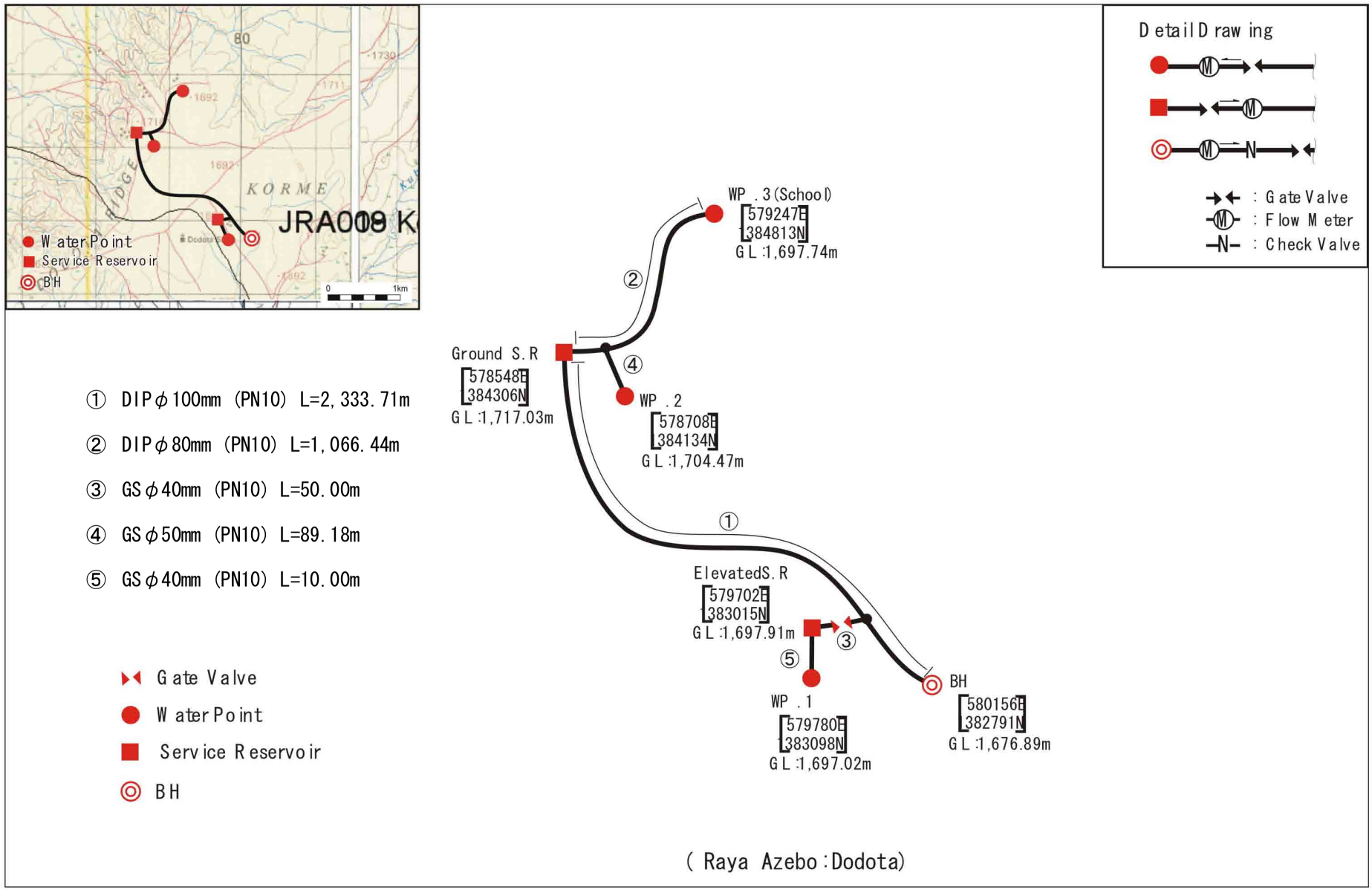


Figure 2-25: Layout for Water Supply Facility at Dodota

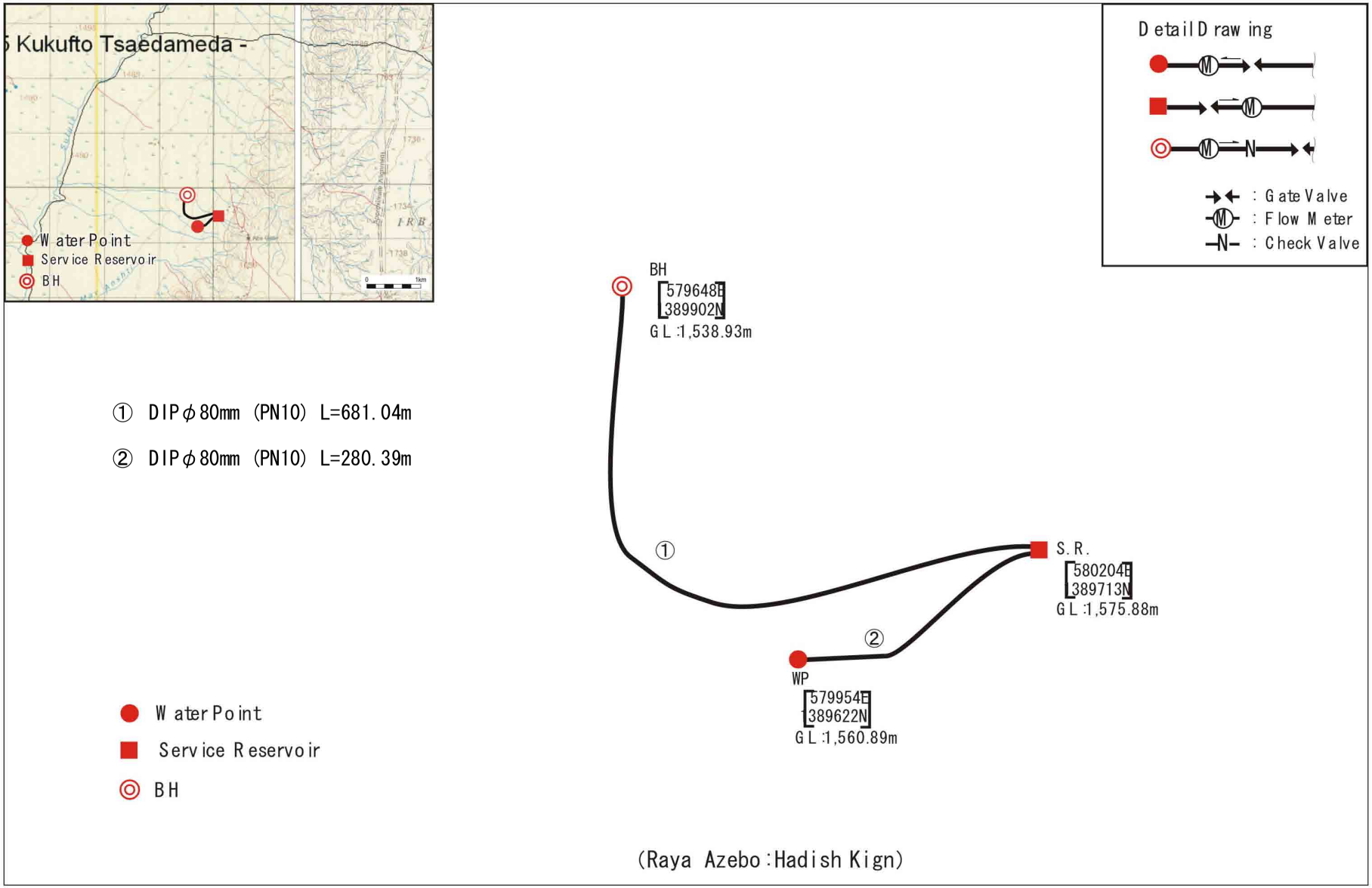


Figure 2-26: Layout for Water Supply Facility at Hadish Kign

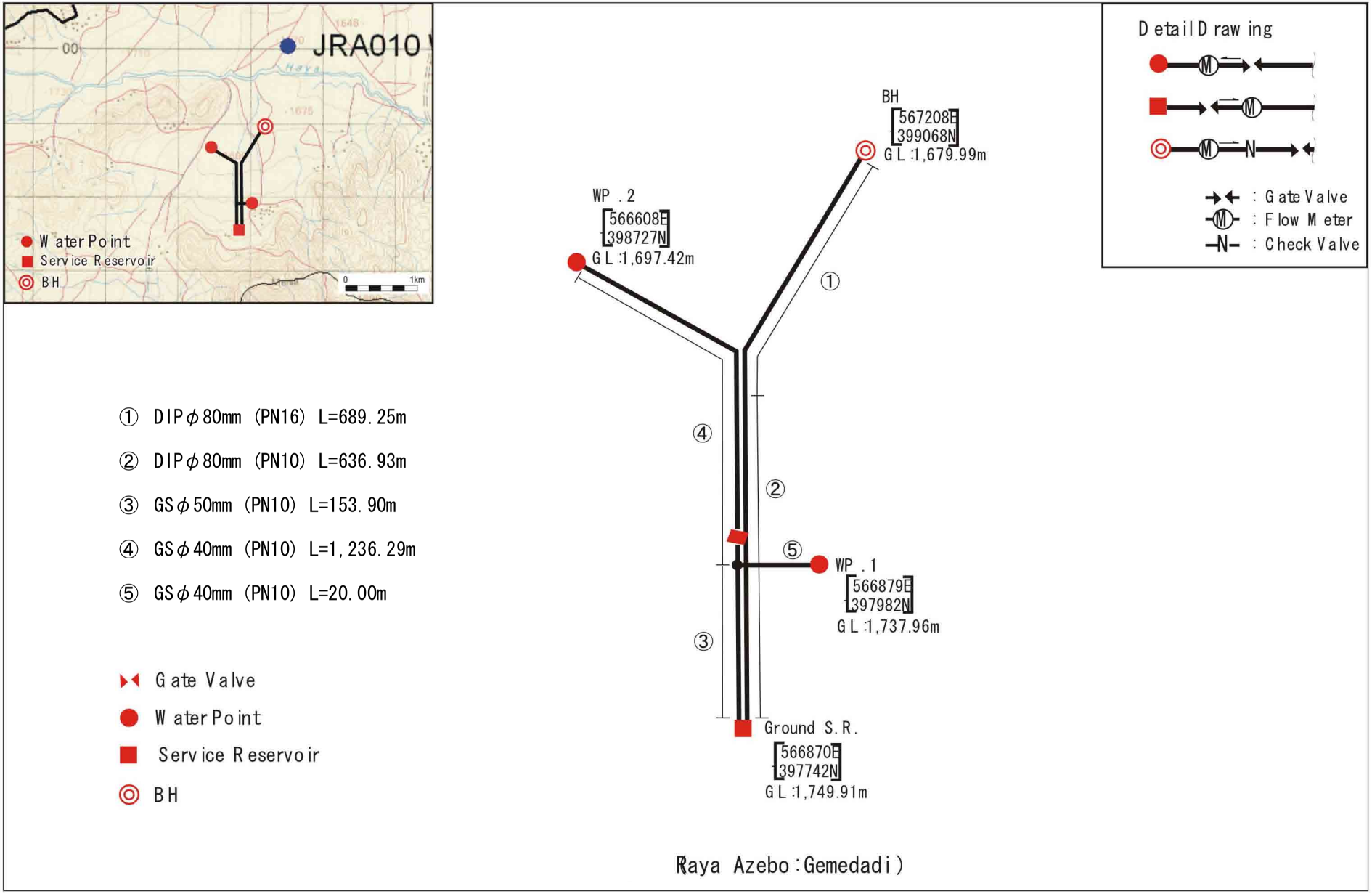


Figure 2-27: Layout for Water Supply Facility at Gemedadi

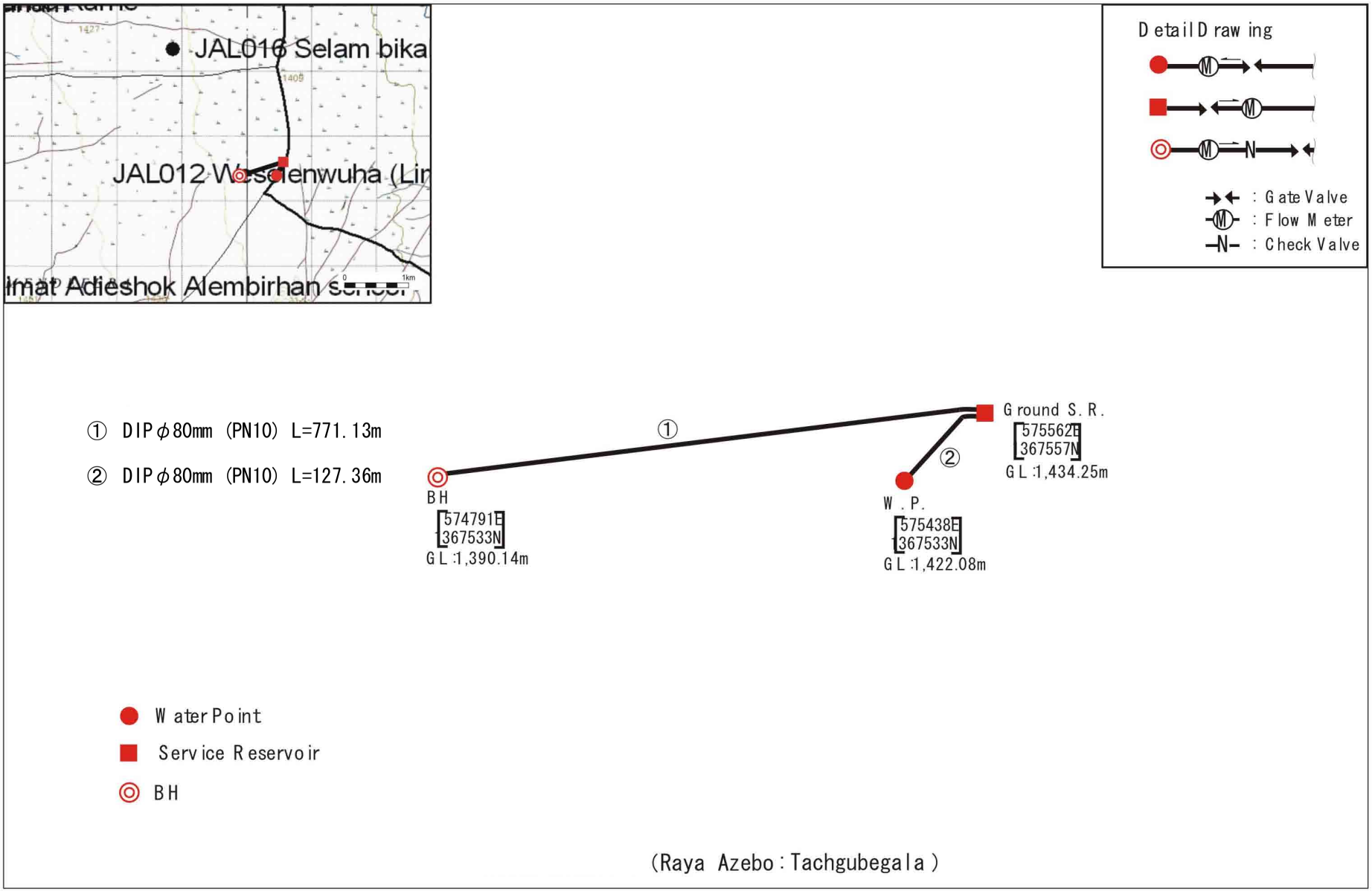


Figure 2-28: Layout for Water Supply Facility at Tachgubegala

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The policy of the implementation plan of the project is formulated based on Japan's grant aid scheme. The policy of the implementation plan is as follows:

(1) Implementation Structure

1) The implementation organization of the project is Tigray Water Resources, Mines and Energy Bureau (TWRMEB).
2) TWRMEB will hire a Japanese consultant to reserve services such as detail design execution, description of tender documents, support on bidding, supervision of facility construction and procurement of materials and equipment.
3) TWRMEB will exchange a contract agreement with the Japanese contractor, and the supervision of the contract will be carried out by the Japanese contractor.
4) Control of the operation and maintenance of water supply facilities and equipment will be transferred to TWRMEB after the completion of the project

The flow chart of implementation is shown in the following figure:

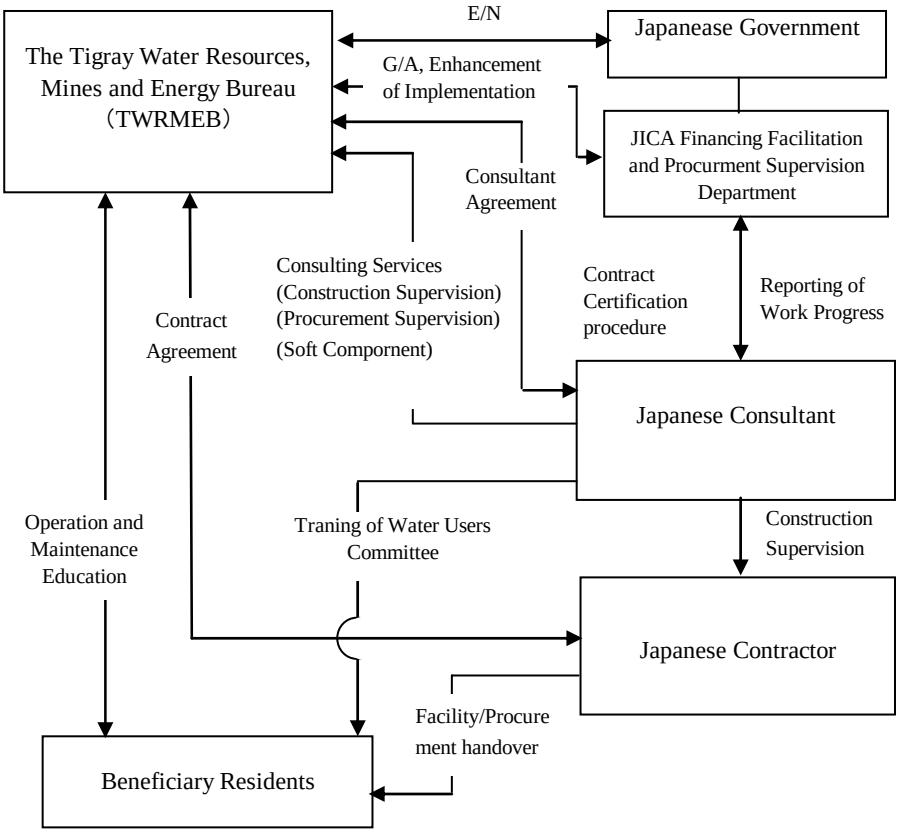


Figure 2-29: Project Implementation Structure

(2) Implementation Policy

1) The work period for this plan, in the Level 1 water supply facilities will require a substantial 20.1 months from the time of contract to completion, in the Level 2 water supply facilities, from the fact that supply/transport of the equipment and materials for water supply facility construction is included, will require a substantial 26.8 months from the time of contract to completion.

2) Good judgment is needed during construction of wells because, on top of the sites being scattered and a large number of wells to drill, the hydrogeological conditions are complicated. For some of the sites, special drilling technologies such as sealing techniques are required for layers contaminated with high concentrations of sulfate. Therefore, in this project, well drilling will be done by a local contractor under the guidance of Japanese drilling engineers.

3) The overall work schedule includes critical work for facility construction of installing pump equipment and electrical equipment, and concrete work required for watertight distribution reservoirs, as well as laying down approximately 36km of pipeline overall, which will require scrupulous schedule management, material and quality management. Thus, in this project, a local contractor will be used under the management of a Japanese engineer capable of comprehensively managing the three elements of quality, schedule and safety, and technician capabilities as the work management system.

4) There are few mechanics and electrical engineers in Ethiopia who can conduct the comprehensive installation of a motorized pump and electric power distribution equipment, therefore a Japanese skill worker for mechanical and electrical work is dispatched occasionally.

(3) Procurment Policy

1) The procurement period of equipment will take 11 months from the time of contract to completion, because it will take 8 months for production of the equipment and 3 months for transportation.

2) In the procurement plan, spare parts for the equipment procured in Japan or a third country will be included, because it is difficult to get the low priced spare parts easily in Ethiopia. The procurement of spare parts will be planned as the quantity necessary for one year maintenance. After this, the procurement of spare parts shall be borne by the recipient country.

3) The service rig for the project is a specific type that requires initial operation instruction by the manufacturer. Therefore, initial operation instruction will be conducted by a Japanese instructor.

2-2-4-2 Implementation Conditions

(1) Accessibility to the Site

There is no concern about accessing target communities in the dry period; however, road conditions worsen in the rainy season and it is expected that access to certain locations will be difficult. It is necessary to carry out an adequate investigation into the accessibility of each community, followed by a plan for the construction schedule.

(2) Safety control

The northern part of the Tigray Region located near the border with Eritrea of the northern is an evacuation area and also the east side of the main road which connects Mekele to Alamata is specified as Level 3 by the safety standards of the United Nations. Although the project site is located in the southeast part of Tigray, there is no significant issue on safety. However with respect to the communication conditions, it is a very poor area, therefore, it is necessary to secure a satellite cellular phone for emergency contact.

(3) Procedure for Tax Exemption

It is anticipated that a great deal of time will be required to perform the procedures necessary for tax exemptions, which effect a number of organizations, starting with TWRMEB, RBA, ECA and so forth. TWRMEB will take the initiative to implement the tax exemption procedures for this project, however it is necessary that the consultant and contractor side sufficiently understand the laws and regulations of Ethiopia concerning tax exemption, promptly prepare documents and carry out application procedures.

2-2-4-3 Scope of Work

Should this plan be executed through grant aid provided by Japan, the division of responsibilities for operation/supply and installation between the Ethiopian-side and the Japanese-side will be as shown below.

Table 2-33: Division of Work provided by Japan and Ethiopia

Division of Labor Duties	Japanese Side	Ethiopian Side
1. Hand Pump Well Facilities		
1.1. Secure land for facilities		○
1.2. Prepare access roads		○
1.3. Provide temporary construction site		○
1.4. Well construction	○	
1.5. Platform construction, installation of hand pumps	○	
1.6. Construction of fence		○
2. Motorized Pump Well Facilities		

2.1. Well construction		
2.1.1. Secure land for construction		○
2.1.2. Prepare access road		○
2.1.3. Provide temporary construction site		○
2.1.4. Construct well	○	
2.2. Construct distribution reservoir		
2.2.1. Secure land for construction		○
2.2.2. Prepare access road		○
2.2.3. Contract distribution reservoir	○	
2.3 Generator room, public tap, livestock trough construction		
2.3.1. Secure land for construction		○
2.3.2. Prepare access road		○
2.3.3. Construct generator room	○	
2.3.4. Construct public tap and livestock trough	○	
2.3.5. Construct fence and gate		○
2.4. Laying Water Main and Distribution Pipe work		
2.4.1. Secure land for construction		○
2.4.2. Prepare access road		○
2.4.3. Lay water main and distribution pipe work	○	
2.5 Motorized pump and generator installation		
2.5.1 Install motorized pump and generator	○	
2.5.2 Lay electric transmission and distribution lead-in lines		○
3. Rehabilitation Work		
3.1. Secure land for construction		○
3.2. Prepare access road		○
3.3. Lay supply and distribution pipeline	○	
3.4. Construct generator room, public tap and livestock trough	○	
3.5. Install motorized pump and generator	○	
3.6. Construct fence and gate		○

2-2-4-4 Consultant Supervision Plan and Procurement Management Plan

(1) Detail Design

1) Confirm budgetary provisions for the construction paid by the Ethiopia side

2) Implementation of supplementary survey for hydrogeology

3) Decide the final location for drilling point of new well facilities

4) Verify points of concern from the study of all target villages and work plan

5) Check and cooperate with EWTEC side for the soft component of this project

6) Coordinate any design changes from the basic design

7) Verify each the meteorological, topographic and geologic conditions

8) Test-drilling wells drilled for Level 2 water supply facilities

9) Verify the design of Level 2 water supply facilities

10) Verify constructions materials, cost of labor and equipment rental fees, etc

11) Confirm a place to store materials of implementation organization

(2) Preparation of Tender Document

Together with the preparation of the tender document based on project designs, documents

required for tender will be prepared and their content discussed with the Ethiopian side before approval.

(3) Tendering (On behalf of Ethiopian side)

The Ethiopian side will undertake public announcement of the tender, audit of tender qualification, distribution of tender specifications and accept, analyze and evaluate the bids. Assistance will be given to conclude the contract between the Ethiopian government and the successful party.

(4) Supervision of Construction / Procurement of Equipment and Soft Component

The consultant will conduct supervision over the construction of water supply facilities, supervise procurement of provisional equipment and undertake the soft component.

1) Construction Supervision

a) Inspect and approve construction diagrams and such

b) Examine and approve quality management

c) Handle cases of faulty wells

d) Examine and provide guidance for policy to deal with problems that arise

e) Final inspection

f) Approve payment

g) Inspection following completion of construction

2) Procurement Supervision

a) Approve instrument production drawings

b) Factory visit

c) Meeting concerning cross-check for inspection prior to shipment

d) Oversee guidance on initial operation

e) Oversee inspection of delivered goods and handover

(5) Personnel assignment

The personnel required for construction supervision, procurement supervision and the soft component, which will be conducted by the consultant, is listed in the Table below.

Table 2-34: Japanese-side Supervision Personnel for Construction & Supply

Supervising Personnel	Area of Supervision	Dispatch Period
Construction Supervisor	Supervise overall duties Administration of final inspection of supply facilities and material provision	Spot supervision

Resident Supervisor	Site supervision during construction, response to change in design, etc.	Resident
Well Drilling Specialist	Initial period of well construction, mid-term spot supervision	Spot supervision
Facility Supervisor	To make spot checks performance of Level 2 water supply facility machine during the middle to end of the project.	Spot supervision
Equipment Procurement Supervisor	Equipment procurement plan, inspection, handover	Spot supervision
Completion Inspector	Final inspection upon completion of work	Spot supervision
O&M/Sanitation Ed./Evaluation	Guidance for maintenance control	Spot supervision

2-2-4-5 Quality Control Plan

Quality control tests will be conducted on the following items.

Table 2-35: Quality Control Test

Type of Work	Quality Control Test	Amount of Tests
Well Construction	Water quality analysis	82 points
Pipe Distribution	Water pressure test	Pipe distributed area
Concrete Casting	Aggregate material testing	Every purchasing contractor
	Reinforcing bar tensile test	Every purchasing contractor
	Concrete mixture test	Before construction
	Concrete testing (slump, air volume, salinity, compression test)	Per casting
Distribution reservoir Construction	Leakage test	10 facilities
Elevated Tank Construction	Soil bearing test	4 facilities

2-2-4-6 Procurement Plan

(1) Construction Equipment/Material

Of the materials required for the project, the fundamental materials such as cement, aggregate, iron reinforcement, steel frame, and timber, as well as secondary goods generally available such as, block, and tile, shall be procured locally wherever possible. However, it has been assumed that the procurement to satisfied quality and quantity of ductile pipe (DIP), GS (galvanized steel) pipe and other special pipe fittings and valves, measurement instruments such as pressure gauges and flow meters, electricity and machine parts for pump facilities will be difficult to obtain in the limited time frame due to the small number of agents at the local. Because of this, these items shall be procured in Japan or a third country. The procurement source of construction materials and equipment for the project will be carried out as shown in Table 2-36.

Table 2-36: Construction materials procurement source

Equipment and Materials	Procurement Source			Remarks
	Japan	Ethiopia	3rd Country	
Cement		○		
Fine aggregate		○		
Coarse aggregate		○		
Steel material		○		
Formwork material		○		
timber		○		
Fuel		○		
GS pipe (galvanized steel pipe)		○	○	Taiwan, Thailand
Ductile pipe (DIP)	○		○	China, Thailand
Valves	○		○	China, Thailand
PVC		○		
Hand pump		○		
submersible pump with accessory		○		
Generator with accessory		○		

*In the design stage of the consulting service, procurement sources of construction materials will be reexamined.

(2) Intercontinent Transportation

Djibouti Port will be used for the import and export of materials and equipment. In the Tigray Region, general customs procedures take place at the customs office in the regional capital of Makele. Therefore, in this plan as well, direct transit will be arranged from Djibouti to Makele, designating Makele as the principal location to handle these procedures.

Moreover, the distance of transportation from Djibouti to Makele is approximately 940 km (of that, approx. 580 km is paved road).

(3) Labor

In Ethiopia, concerning the utilization of construction technicians, carpenters, plasterers, and common labor for construction works, their services will be employed wherever applicable. However, there are few technicians and construction engineers in Mekele that are able to execute comprehensive construction, so these technicians will be employed in Addis Abeba.

(4) Construction Equipment

Commonly used equipment such as drilling rigs, backhoes, dump trucks, and truck-mounted cranes are available locally for leasing. Therefore, the equipment will basically be leased locally.

2-2-4-7 Operational Guidance Plan

The service rig for the project is a specific type that requires initial operation instruction by the manufacturer. Instruction will given to the operator staff in the Central Workshop of TWRMEB. Instruction on the generator, control panel, initial operation of submersible pump, bulbs, flow meter, operation and maintenance of hand pump, replacement of spare parts and trouble shooting will also be conducted in the soft component programme. The following table indicates the plan for operational guidance.

Table 2-37: Initial Operation Instruction and Guidance

Facility Type		Contents	Target
Equipment	Service Rig	Operation Method Maintenance Method	Engineer and /or operator in the Central Workshop
Hand pump and well facilities	Hand pump	Replacement of U seal, O ring	Water Users Group
Submersible pump and water supply facilities	Intake facility	Operation of submersible pump, maintenance and inspection method	Water Users Group
		Operation of generator, maintenance and inspection method. Replacement of consumable supplies and material	Water Users Group
		Operation of control panel, maintenance and inspection method	Water Users Group
	Pipe line	Operation of valve	Water Users Group
		Inspection of seepage	Water Users Group
	Public tap	Maintenance of flow meter	Water Users Group

2-2-4-8 Soft Component (Technical Assistance) Plan

(1) Background

The objective of the Project is to “increase the population that receives safe and reliable water supply in the target areas.” In the sites where new facilities are to be constructed in the Study, it is necessary to create a new organization for operation and maintenance of the facilities and to clarify the regional government’s support system, in addition to providing assistance and technical guidance for O&M activities by residents. Therefore, by planning the Soft Component, it will provide assistance to ensure the smooth establishment of an operation and maintenance system so that villagers can receive sustainable water supply services.

(2) Objective

Based on the above background and the operational problems and countermeasures, the

objective of the soft component is for "operation and maintenance by residents to be adequately carried out" during the project period. The top goal is for the water supply facilities constructed in the Study to be used long after the project is complete.

(3) Results and Means of Confirmation

The results are generally divided into five categories. The respective results are shown in Table 2-38 and the index and means confirmation are shown in the table below.

Table 2-38: Results and Means of Confirmation

Number	Results	Index of Achievement	Means of Confirmation (Draft)
1	Residents operate and maintain facilities with sense of ownership	1. Do the concerned organizations have a common understanding of residents' role in operation and maintenance?	1. Interviews with concerned organizations
2	Village Water Committees (VWC) and their support system and roles are clarified	1. Are the roles of each organization concerned with the O&M system clear?	1.Organizational chart of O&M system
		2. Does each organization concerned have a clear understanding of its role?	2.Interviews with concerned organizations
3	A resident-centered O&M plan is formulated and practiced in each village.	1. Have water use rules been established?	1.Water use rules
		2. Is the handling of maintenance/repairs clear?	2. Bylaws for maintenance/repair
		3. Is monitoring/ evaluation being implemented according to plan?	3. Monitoring records
4	The concerned organizations acquire the necessary skills for O&M	1. Is the period of breakdown shortened?	1.Records of WWRMEO activities
		2. Is the frequency of breakdown reduced?	2.Log of facility operation
		3. Have records of fee collection and facility operation been kept?	3.Various ledgers
5	Residents' concept of hygiene/sanitation is improved	1. Has resident's hygiene awareness been raised?	1. Questionnaires for residents

(4) Activities (Input Plan)

The content, target participant and implementer of the activities are summarized in the table below. While making effective use of local resources, in principle Japanese consultants (or local consultants subcontracted based on the guidance of Japanese consultants) are to take part in all activities. Depending on the activity content, the activities will be implemented with the cooperation of regional government staff such as TWRMEB, WWRMEO, etc. and EWTEC.

Table 2-39: Input Plan

Activity	Content	Form	Target participant	Implementer (collaborator) = Input
1	Provide education on resident participation to concerned organizations	Workshop	TWRMWO staff, WWRMEO staff	Japanese consultant (someone who has participated in EWTEC or EWTEC)
	Organize village meeting to obtain understanding about the Study	Resident meeting	VWC, WUGs, residents	WWRMEO staff (local consultant)
2	Review activities of VWC thus far and re-examine how they are conducted	Workshop	VWC, residents	Local consultant (WWRMEO, WUGs)
	Establish resident -centered O&M system including support through coordination with concerned organizations.	Workshop	VWC, residents, TWRMEB staff、WWRMEO staff, etc.	Japanese consultant (WWRMEO, NGO, other donors)
	Organize joint committee meeting based on the concerned organizations	Joint committee meeting	Constituent members of O&M system	Local consultant (Japanese consultant)
3	Formulate an O&M plan including water use rules, response to breakdown, etc. in each village	Workshop/OJT	WWRMEO staff, residents	Local consultant (Japanese consultant)
	Implement O&M activities according to formulated plan	Monitoring/activity records	Residents, constituent members of O&M system	Local consultant (Japanese consultant)
	Monitor/Evaluate activities and revise the plan	Joint committee meeting	Members of O&M system	Japanese consultant (Local consultant)
4	Conduct training on methods of resident participation for concerned organizations	Seminar, on-site OJT	WWRMEO staff, VWC, WUGs	Local consultant (Japanese consultant)
	Conduct technical training for facility repair.	Seminar/Practical training	TWRMEB staff, WWRMEB staff	Japanese consultant (someone who has participated in EWTEC or EWTEC)
	Conduct technical training on facility repair for VWC Facility Caretaker	Practical training	VWC Facility Caretaker	WWRMEO staff (Japanese consultant)
	Conduct training on administrative skills for VWC Treasurer.	Practical training/ Seminar	VWC Treasurer	Local consultant (Japanese consultant)
5	Provide hygiene education to residents.	Seminar	Residents	WWRMEO Community Development Officer (Local consultant)
	Provide guidance on hygiene patrols to residents.	Guidance on hygiene patrols	VWC	WWRMEO staff

(5) Procurement Method of Implementation Resources

Regarding the Input Plan in the Soft Component, the Japanese consultant (spot supervision) for operation and maintenance will essentially participate with the local consultant at the initial and final stage of the activities in each phase, confirming the purpose and direction of the activities with the local consultant.

The following are being considered for the local consultant.

① Professional Consulting and Business PLC （local subcontractor that conducted the

socio-economic study in Basic Design Study; members consist mainly of professors and graduate students from Mekele University)

② Private consultant; retired TWRMEB worker involved in O&M activities of village water supply

(6) Implementation Schedule

The O&M activities consist of a total of four field works by the Japanese consultant. The contents to be implemented in the Soft Component are generally divided into the following two phases:

- Activities for launching a new organizational system (Phase I, mainly before construction)
- Practical training/On-site guidance and OJT (Phase II, during and after construction)

The activities before construction (Phase I) are expected to take approximately 5.1 months. However, in order for government staff to take part in launching a new organizational system at sites that do not yet have a management system such as village water committees, in the initial one month period the Japanese consultant will explain the plan for O&M and the concrete Soft Component plan to mainly regional and woreda government staff. Based on that plan, local staff will go to the target sites with the responsible government staff and implement the overall activities for launching the new system, although it is determined to be unproductive for the Japanese consultant to stay on-site during this period. The Japanese consultant will return to the site in the final stage of this process to examine the methods of coping with the problems encountered and if necessary, revise the O&M plan. The follow up work is to be entrusted to the regional/woreda government staff.

In Phase II, the Japanese consultant will provide practical training on management techniques and education on administrative methods to the O&M organizations. In the initial stage of Phase II, on-site OJT will be conducted based on the constructed facilities (in some cases, existing facilities) for facilities that are relatively difficult to operate and maintain, such as Level 2 systems. Subsequently, the Japanese consultant will provide the same training to the government staff in charge of the local consultant for each village. In the final stage, the Japanese consultant will conduct a review based on the results of “the new organizational system launch”, “O&M practice”, and “monitoring” implemented thus far and if necessary, reconsider the operational method of the organizational system to produce a system that can be handed over to the responsible regional government staff.

The schedule consists of 1) before construction (5.1 months) and 2) during and after construction (21.4 months), and of the overall 29.3 month implementation schedule, the Japanese consultant will conduct four field activities (4 months) at the beginning and end of each phase. The activities

of the local consultant are expected to take 12.27 months.

(7) Results

The results of the Soft Component with respect to each activity are set as follows:

Table 2-40: List of Activities and Results

Activity	Results
1.1 Provide education on resident participation to the concerned organization.	Workshop reports
1.2 Organize village meetings to gain understanding of the Study.	Minutes of meeting
2.1 Review the activities of the VWC thus far and re-examine how they are conducted.	Written agreement on VWC
2.2 Establish a resident-centered O&M system including support through coordination with the concerned organizations	Organizational chart of O&M system
2.3 Organize joint committee meeting based on concerned organizations.	Minutes of meeting
3.1 Formulate an O&M plan including water use rules, response to breakdowns, etc. in each village.	O&M Plan Monitoring sheets
3.2 Conduct O&M activities according to formulated plan.	Activity records
3.3 Monitor/Evaluate activities and revise plan.	Monitoring results Evaluation result Revised O&M plan
4.1Conduct training on resident participation methods to concerned organizations.	Training Implementation Reports
4.2 Conduct technical training on facility repair for TWRMEB, WWRMEO.	Training Implementation Reports
4.3 Conduct technical training on facility repair to VWC Caretaker	Training Implementation Reports
4.4 Conduct training on administrative skills for VWC Treasurer.	Training Implementation Reports
5.1 Provide hygiene education to residents.	Hygiene Education Implementation Report
5.2 Provide guidance on hygiene patrols to residents.	Records on patrol guidance

The above activities will be evaluated and examined, and the reports below will be submitted during and after implementation of the Soft Component.

1. Soft Component Implementation Report
2. Soft Component Completion Report

(8) Responsibilities of the Ethiopian Government

①Notify and make preparations for each woreda and target village regarding the contents to be implemented in this plan

③ During implementation of the plan, secure the necessary workspace, equipment for education and bear the expenses for preparation of materials, etc.

④ Assign government staff concerned with the project

⑤ Bear the expenses of on-site activities, transportation, accommodation and daily allowance for government staff concerned with the project

⑥ Request and obtain permission from the central government for activities concerned with

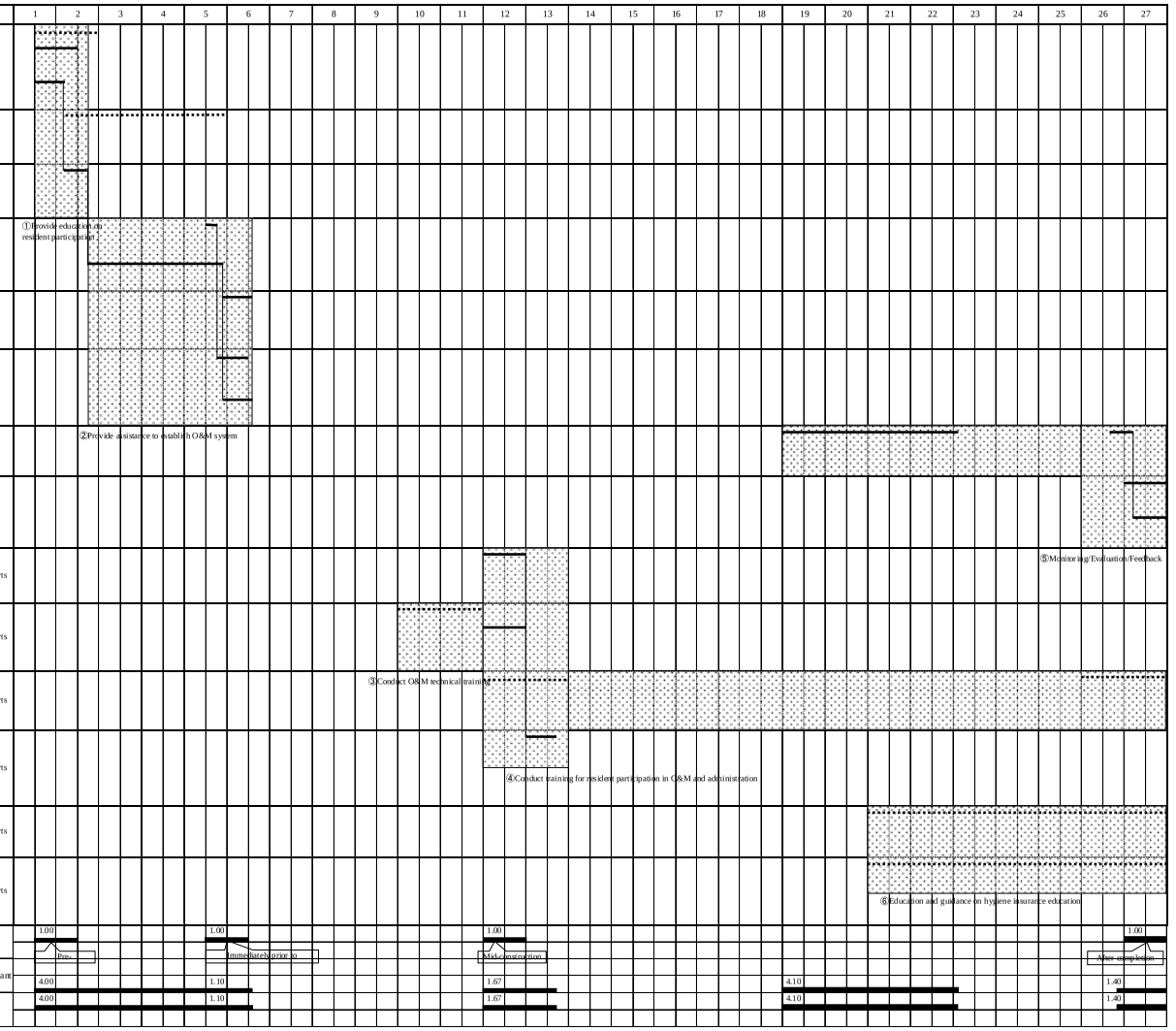
EWTEC

⑦ Bear the expense for activities concerned with EWTEC

⑧ Prepare venue for workshops, etc. and bear the expense of holding workshops

Table 2-41: Activity Schedule for Soft Component

Activity No.	Content	Target	Stage/Place/Period	Input	Results
1.1	1.1 Provide education on resident participation to the concerned organization.	TWRMEB[2] WWRMEO[3]	・Before construction ・Region, each Woreda (10 Woredas) ・20 days	・EWTEC[1] ・Japanese consultant (O&M management supervisor) ・Local consultant ・Vehicle	Workshop report
1.2	1.2 Organize villege meetings to gain understanding of the Study.	Residents of target villages, Villagecouncil	・Before construction ・Target village for facility construction (94 villages) ・1 day x 94 villages	・WWRMEO (local consultant) ・Vehicle, design diagram	Minutes of meeting
2.1	2.1 Review the activities of the VWC thus far and re-examine how they are conducted.	VWC (and residents) of target village <Observer> WWRMEO, Village council	・Before construction ・Target village for facility construction (10 Woredas x 1.5 days) ・15 days	・Local consultant ・Vehicle	Written agreement on VWC
2.2	2.2 Establish a resident-centered O&M system including support through coordination with the concerned organization.	Resident, WC, TWRMEB, WWRMEO NGO, Other donor, Village council	・Pre-construction ・Target village for facility construction (94 villages x 1 day) +97 days (3 days for preparations)	・Japanese consultant (O&M management supervisor) ・Local consultant ・Vehicle	Organizational chart of O&M system
2.3	2.3 Organize joint committee meeting based on concerned organizations.	Members of O&M system	・Once per quarter, pre-, mid- and post-construction ・Target village for facility construction (10 Woredas x 2 days) ・20 days	・Local consultant ・Vehicle	Minutes of meeting
3.1	3.1 Formulate an O&M plan including water use rules, response to breakdowns, etc. in each village.	Residents of target villages, Village council WWRMEO	・ Pre-construction (agricultural off-season) ・Target village for facility construction (10 Woredas x 2 days) ・20 days	・Japanese consultant (O&M management supervisor) ・Local consultant ・Vehicle	O&M Plan Monitoring sheet
3.2	3.2 Conduct O&M activities according to formulated plan.	Resident, WC, TWRMEB, WWRMEO NGO, Village council	・Post-construction ・Target village for facility construction ・141days	・Local consultant ・O&M Equipment and Materials	Activity records
3.3	3.3 Monitor/Evaluate activities and revise plan.	Resident, WC, TWRMEB, WWRMEO, MoH NGO, Village council	・Post-construction ・Target village for facility construction ・ Quarterly monitoring. Evaluation once/year ・24 days	・Japanese consultant (O&M) ・Local consultant ・Vehicle	Monitoring results Evaluation results Revised O&M plan
4.1	4.1Conduct training on resident participation methods to concerned organizations.	WWRMEO, WC, Village council	・Pre-construction ・Each Woreda (10 Woreda) ・30 days	・Local consultant ・ Vehicle, Materials for resident participation	Training Implementation Reports
4.2	4.2 Conduct technical training on facility repair for TWRMEB, WWRMEO.	TWRMEB, WWRMEO	・Mid-construction ・Each Woreda (10 Woreda) ・30 days	・EWTEC ・Japanese consultant (Facility supervisor) ・Vehicle, Repair equipment	Training Implementation Reports
4.3	4.3 Conduct technical training on facility repair to VWC Caretaker.	Facility Supervisor of WC	・Mid-construction ・ Assemble and train supervisos in each Woreda ・20 days	・WWRMEO(local consultant) ・Vehicle, Repair equipment ・ Participant travel cost, daily allowance	Training Implementation Reports
4.4	4.4 Conduct training on administrative skills for VWC Treasurer.	Accountant for WC, Committee Chair	・Mid-construction ・ Assemble and train supervisos in each Woreda ・20 days	・Local consultant ・Vehicle ・ Participant travel cost, daily allowance ・Training materials	Training Implementation Reports
5.1	5.1 Provide hygiene education to residents.	Residents of target village for facility construction	・Project implementation period ・Target village for facility construction ・1 day x 2time x 94 village	・Woreda Insurancestaff ・Vehicle ・Materials for hygiene education	Training Implementation Reports
5.2	5.2 Provide guidance on hygiene patrols to residents.	Resident groups of target village for facility construction	・Project implementation period ・Target village for facility construction ・Patrol once in two months	・NGO, village volunteers ・Vehicle ・Bicycle	Training Implementation Reports



LEGEND

Note 1 EWTEC = Ethiopia Water Technology Center

2 TWRMEB = Tigray Water Resource Mines & Energy Bureau

3 WWRMEO = Woreda Water Resource Mines & Energy Office

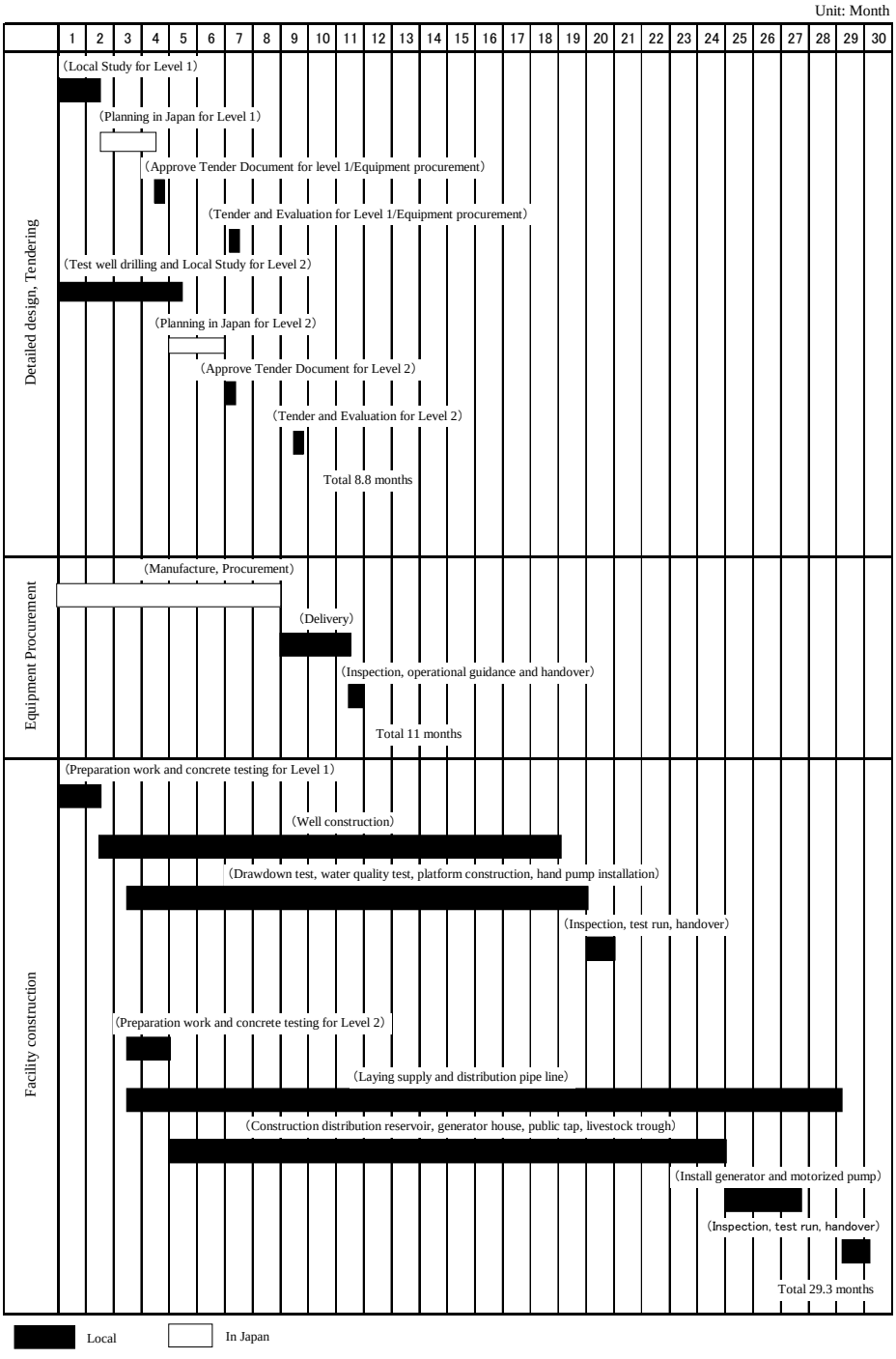
Soft-component schedule: Japan side

Soft-component support framework of local resources

2-2-4-9 Implementation Schedule

The implementation schedule for the project will require 8.8 months for the detailed design and bidding process after the exchange of note by both countries. The works for the procurement is scheduled as 11 months. A substantial 29.3 months scheduled for water supply facility construction from the time of contract to completion.

Table 2-42: Implementation Schedule



2-3 Obligations of Recipient Country

The Recipient Country of Ethiopia shall fulfill the following obligations:

① Provide relevant data, information and materials necessary for the execution of the project

② Accord Japanese nationals engaged in the Project such facilities as may be necessary for their entry into Ethiopia and stay therein for the performance of work as well as ensure their safety at the project site

③ Expedite the clearance procedures in connection with equipment procured for the project

④ Exempt Japanese nationals from customs duties, internal taxes and other fiscal levies imposed in the recipient country with respect to the supply of equipment and materials

⑤ Obtain the vehicle identification numbers for vehicles procured for the project

⑥ Provide facilities for office space as well as a Counterpart for the Japanese consultants

⑦ Provide facilities for office space and motor pool space for the Japanese construction work contractor

⑧ Lend equipment which is maintained by the Ethiopian-side as well as required personnel for OJT to the Japanese-side construction work contractor as has been agreed upon previously

⑨ Maintain proper use of materials and equipment procured and see to the appropriate maintenance of facilities constructed for this project

⑩ Bear the initial costs for wiring installation by Ethiopia Electric Power Company to the electrical pump in the case commercial power is used for Level 2 facilities

⑪ Bear responsibility for the following costs which according to the rules and regulations for Grant Aid cannot be borne by the Japanese-side;

- D/D, soft component, and labor costs for necessary personnel OJT participation
- Payment of processing fees pertaining to Banking Arrangement (B/A) and Authorization to Pay (A/P)
- Facilities for workshop as well as the storage of procured equipment and materials
- Land for well construction and development/land improvements for access to well construction locations
- Heavy machinery costs pertaining to road construction in those cases where heavy machinery is necessary for the construction of access roads
- C/P daily allowances, etc., such as estimated expenses for counterpart engineers, pertaining to the project.

2-4 Project Operation Plan

The structure for operation and maintenance has been divided into two levels; the implementation organizations (TWRMEB, WWRMEO) and the villages or communities (see Figure 2-30)

The implementation organizations will assist in the structure of the citizen operation and

maintenance organization, provide support and education on sanitation to the communities or villages. Also, the division of roles has been clarified so that major repairs will be the responsibility of TWRMEB and minor repairs will be handled by WWRMEO.

At the village level, a Water Committee (hereinafter WC) will be established at each water source[4], and undertake daily facility operation, collection of the water fee, cleaning, repairs and so on. Also, a Village Water Committee (hereinafter VWC) will be established at each village, and will oversee the WC as well as act as the representative body to make request to the operation support organizations TWRMEB, WWRMEO for facility repairs and spare part supply.

(1) Water Supply Facility Operation and Maintenance Plan

1) Burden Sharing Pertaining to Maintenance

a. Minor Repairs (damage with no affect on packing, etc., of pump structure, cylinder structure)

WUG will analyze and examine the problem area → VWC will make required arrangements and parts replacement.

b. Major Repairs (required repair due to pump damage, cylinder replacement)

WUG、VWC will make examinations → WWREMO、TWRMEB will make required arrangements and parts replacement.

c. Problem Solutions in Relation to Organization Management Aspects

VWC acknowledges problematic points, grasps the situation and draws up countermeasures, with guidance from WWREMO where necessity applies.

2) Maintenance System

a Management System of technical aspects

- For government promoted unification of material and equipment, inventory at the Central maintenance workshop shall be managed to account for the stock of principle parts.
- However, because the purchase revenue source is not guaranteed, while receiving the public finance support of TWRMEB, the collection system of the GTZ service fee, and the distribution and buying plan will be respected.
- For Level 1 facilities, WWRMO shall make necessary arrangements based on cooperation with WUG and VWC.
- For Level 2 facilities, WUG, VWC and WWRMO shall make arrangements in cooperation with TERMEB.
- EWTEC shall enhance cooperation with other donors to master skills pertaining to the

above items.

b. Management System of water supply organizational operation

- Although there are differences between some of the project regions pertaining to the O&M system, the functionality is favorable in general.
- Cooperation is planned with aid organizations (Community Facilitation Team, Woreda Water Desk) operated by WB, UNICEF and such, aiming for UAP achievement.
- Re-examine the activity support system of the community support supervisor in WWRMO, making community support activities a core issue.
- EWTEC shall enhance cooperation with a regional consultant in order to master skills pertaining to community support.

c. Water User Group (WUG) Activity Assistance

- O&M is considered to be functioning effectively due to WC, excluding some villages.
- Therefore the current system is utilized to its maximum limit, and furthermore to take measures to correct the ability differences between communities and strengthen the current system.
- In detail, implementing an information campaign and training of community support supervisors in WWRMO, and support to plan and implement those activities provided by TWRMEB.

[4] At each water pump for Level 1, and at each public water tap for Level 2

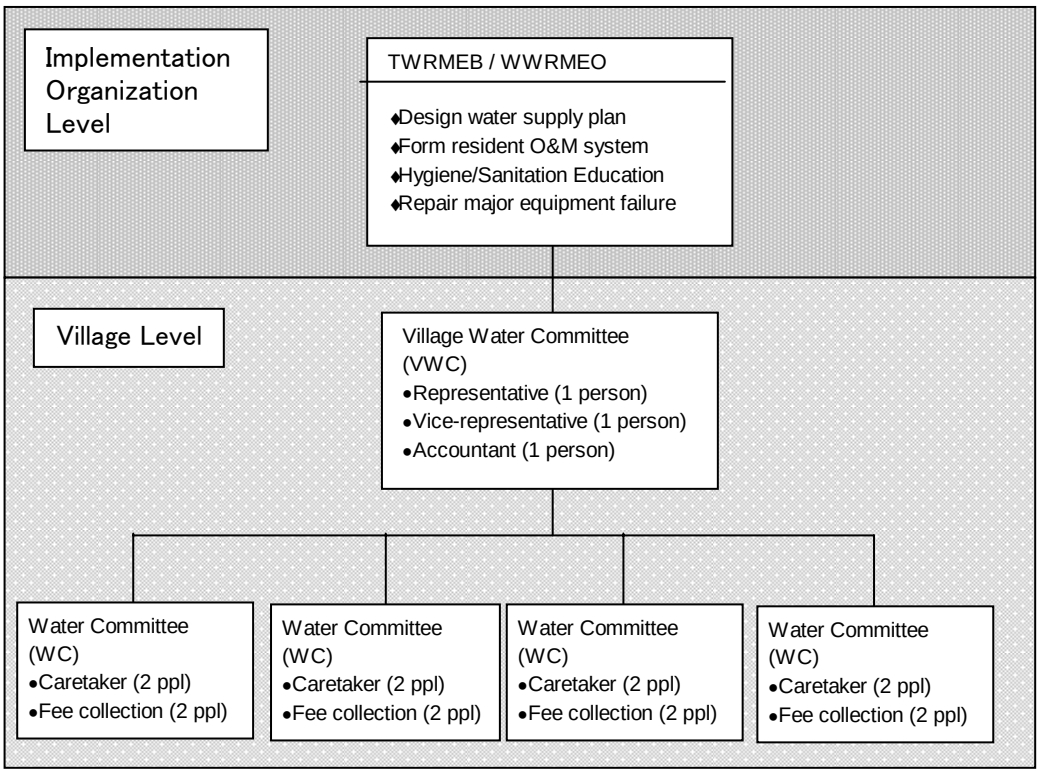


Figure 2-30: O & M Organization

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

The total cost for Ethiopia side including the fence work, construction of access roads, construction of primary distribution of commercial electricity, budget of tax exemption and so on, is approximately 28.4 million Ethiopia Birr.

Table 2-43: Estimation of costs borne by the Ethiopia side

Item	Cost (million Ethiopian Birr)
Fence work	1.4
Construction of access roads	1.5
Primary distribution of commercial electricity	0.3
Budget of Tax exemption for construction materials	13.2
Budget of Tax exemption for Equipment procurement	11.9
Bank charge for B/A and A/P	0.1
Total	28.4

2-5-2 Operation and Maintenance Cost

2-5-2-1 Operation and Maintenance Cost

(1) Level 1 Facilities

The monthly operation fee for Level 1 facilities is shown in Table 2-44.

The results of the socio-economic study showed that 19 Birr is 5%[5] of the average household income. Therefore, imposing a maintenance fee of 3.8 Birr as shown in Table 2-44 is not seen to pose any obstacle.

Table 2-44: O & M Cost per Month for Hand Pump Facility

(Per One Facility, Unit: Birr)

No.	Item	Unit Cost	Quantity	Total	Remarks
①	Procurement of spare parts	850	1 set	850	Unit cost: from quotation of shop
②	Hand pump repair deposit	7,150	5% of main unit cost	350	Unit cost: from quotation of shop
③	Caretaker salary	150	1 person/12 mos.	1,800	Unit cost: result of study
④	Patrol/inspection fee	100	Twice/year	400	Unit cost: from job card by TWRMEB
⑤	Transportation fee	70	Twice/year x 2hrs (1hr R-T)	280	Unit cost: from job card by TWRMEB
⑥	Maintenance mg't cost (Annual)			3,680	Grand Total ①-⑤
⑦	Maintenance mg't cost (Monthly)			307	⑥÷12
⑧	Monthly cost per household			3.8	⑦÷80 household*1

*1 Calculated as 400 users per hand pump location and five person per household

(2) Level 2 Water Supply Facilities

The operation and maintenance cost of a level 2 facility will be calculated for each individual site on account of the variable fuel costs depending on the specifications of the motorized pump installed at the site. The monthly O&M fee and water fee trial balance sheet is shown as calculated for Level 2 facilities in Table 2-45. The water fee, taking into consideration operation costs, was set below the current cost of 0.1~0.15 per Jerri can currently paid in any of the targeted sites, an amount that should not cause any notable burden on the citizens.

Also, the power source primarily used in this project is a generator, however local governments were advised to consider commercial power sources from the view point of cost reduction. As a result, 3 of the facilities have done so. The cost estimation below shows that in comparison with facilities that use generators, those that have utilized commercial power enjoy an approximate 30% reduction in costs.

[5] In an international authority such as the World Bank, the ratio of water fee to overall monthly income per household is between 3 % and 7 %.

Table 2-45: O & M Cost per Month for Motorized Pump Facility

Unit: Birr

Fac. No.	Village	Site	Monthly cost required for Maintenance (Note 1)	Water Fee (per 20L Jerri can)		Water fee estimate		Total ability to pay /per site (Note 2)	Remarks
						Total amount collected per month/per site			
				Required basic fee	Current water fee (Note 2)	Established fee			
						0.1 Birr	0.15 Birr		
1	Gerjele town	Gerjele town	1,758	0.01	0.1～0.15	11,250	16,875	18,254	Uses commercial power
2	Ula	Ula	8,424	0.08	0.1～0.15	5,900	8,849	13,430	Uses generator
3	Hadealga	Hadealga	4,204	0.02	0.1～0.15	5,488	8,232	8,780	Uese commercial power
		Keyih tekli	1,433			8,233	12,349	62,203	
4	Hirka	Hirka	4,545	0.02	0.1～0.15	4,115	6,173	12,803	Uses commercial power
	Adialebachele	Adialebachele				8,233	12,349	18,295	
	Bechenrkatan	Bechenrkatan				4,336	6,504	7,708	
5	Fondel	Fondel	4,914	0.09	0.1～0.15	3,429	5,144	13,716	Uses generator
6	Dodota	Dodota	4,446	0.05	0.1～0.15	4,802	7,202	13,917	Uses generator
7	Arva	Hadishkign	5,616	0.07	0.1～0.15	4,624	6,936	15,755	Uses generator
8	Gendiajo	Gemed dadi	3,510	0.07	0.1～0.15	2,840	4,259	7,572	Uses generator
9	Hadishkign	Tachgubegala	2,340	0.05	0.1～0.15	3,114	4,671	12,733	Uses generator

Note 1: Amount required for maintenance per month (using a generator) = fuel cost x 1.3

(-->30% increase estimated for caretaker salary, equipment consumables (motor pump, generator), spare part, and accessories)

Amount required for maintenance per month (using commercial power) = electricity cost x 1.3

(-->30% increase estimated for caretaker salary, equipment consumables (motor pump), spare part, and accessories)

Note 2: From results of socio-economic study

2-5-2-2 Cost Estimation of Water Fee

As a management maintenance expense of the level 2 facilities, the monthly amount for the water fee to be collected and monthly amount for maintenance cost when set to 0.1 Birr and 0.15 Birr per Jerri can, was compared to the monthly payment possible for citizens according to the socio-economic study (Table 2-45 as reference). As a result, the citizens' ability to pay for the monthly payment far exceeded the monthly maintenance costs in each case. In addition, when setting the water fee to 0.15 Birr, the monthly amount that would be collected exceeded the monthly maintenance cost in all villages. From this, the set water fee is sufficient with current price level, and this price is seen as valid from the economic conditions.

On the other hand, the water fee for the Level 1 facilities is relatively low in comparison with Level 2 facilities because fuel and electric power are not used. Because of that, the water fee amount will be based on the monthly or annual income of each household and adjusted with the economic conditions of each site, taking existing facilities as a reference.

Management methods of the O&M costs are shown below.

(1) At present O&M management is primarily that the water commission will a) REST takes the initiative, and a community fund bank is established, or b) funds are managed by each individual of the WC. Basically, as in the first example, an account is opened at a bank nearby and funds for repair and maintenance are managed jointly, but when there is no financial institution in the vicinity of the village, then the water committee will observe flexible fund management under the guidance of WWRMO.

(2) Prior to well construction, the water management committee or water commission collects the amount established as the O&M reserve fund and opens an account. Furthermore, giving sufficient explanation in regard to the necessity of operation and management, a water usage fee is put in place. In addition, as part of community education, guidance will be given concerning "a safe and continuous water supply" with sufficient explanation so that no one defaults on payment during seasonal dry periods or the rainy season.

(3) There are some poor families in villages which cannot pay water fees. The water control committee or water committee will decide on policy and follow-up measures to construct a system so that even these poor families are able to use the water (such as providing them with the opportunity to clean around the well or assist with the transport of water).

(4) The salary for the caretaker of the above-mentioned fund includes transportation costs for fund management, but funds will be reserved for large-scale repairs, and a collection will be conducted for minor repairs from citizens who will benefit when it is necessary.

2-6 Other Relevant Issue

For the smooth implementation of the project, the following issues shall be given special consideration by the Ethiopian Side.

1) Exemption of value added taxes (VAT) and other fiscal levies imposed in the recipient country with respect to the procurement of equipment and materials
2) Bear the initial costs and implementation of primary installation of power supply by Ethiopia Electric Power Company to the project sites where commercial power is used for Level 2 facilities (preparation of budget before construction is started).
3) Well drilling and acquisition of land to construct facilities (right of usage)
4) Construction and maintenance of roads for the transport of materials and equipment to be used for the construction of wells (manpower, prepare budget)
5) Increase capacity of technicians in the field of water supply at the State and Provincial level
6) Establish and provide guidance to citizen organizations in the target villages
7) Secure the budget and personnel from government staff that will be needed to conduct

activities pertaining to the soft component of the project

8) Secure a space for a local site office