Appendix-5.3

Natural Condition Survey

5.3 Natural Condition Survey

Water Source Survey (including Water Quality Survey)

The basic design study investigated the present conditions of water sources identified mainly by the development study (2002) and the preparatory study (2003), both precedents to the Basic Design Study. The results of the survey of the water sources is summarized in Table A1-1 and described below.

(1) Water Sources

Tarus:

Water supply for Tarus village will be from Tarus spring. As the water from the Tarus spring is presently utilized not only for the Regional Drinking Water Enterprise (PDAM), but also for irrigation purposes, confirmation on the water rights was necessary.

The Study Team confirmed that about 30 L/sec of water is currently not being utilized by the PDAM at the spring and flows out downstream. On the other hand additional water use for the new water supply system will be 10 L/sec at the maximum. As a result the rest, about 20 L/sec of water, will still be available to the area downstream. That is sufficient for the irrigated area downstream.

It was confirmed that the head of the sub-district who is the owner of the spring, agreed on the additional use of water for the water supply scheme.

Duman (Upper)

The upper most hamlet, Kuban Baru, is not supplied with water from the existing water source. A new spring was identified by the development study (May 2002) at a higher location than the existing broncaptering.

The basic design study confirmed through topographic survey that the new water source is located at a position high enough to supply water to Kuban Baru. The basic design study also confirmed the spring yield of 3 L/sec.

Bagik Papan:

The existing water supply system was constructed in 1989 and provided sufficient water from the existing water source (spring). The water yield from the existing water source has declined to 1.3 L/sec (measured by the basic design study team) due to deforestation by re-settlers settled on the area above the spring. As the existing water source is no longer sufficient for the water supply scheme, the recent Development Study (2002) has already identified the new water source (M.A. Balas-I).

It was re-confirmed by this study that the new water source is available for the scheme (no water rights issues exist), and that it has adequate volume and is of good quality.

Labuhan Mapin:

It was reported that the water supply to Labhan Mapin was not sufficient and therefore, development of new water sources would be required.

The observations and conclusions by the basic design study are as follows;

The development study reported that:

Water flow from the spring (M.A. Remas) to the broncaptering was reduced to 6 L/sec (measured in the rainy season by the development study) because a fallen tree damaged the flow path and disturbed the water flow.

PDAM Sumbawa repaired the damage in 2001, resulting in a water flow of 11 L/sec to the broncaptering even in the dry season (measured by the development study).

The basic design study confirmed that:

- Water volume collected by the broncaptering is 9.5 L/sec, and the water flow at the lowest BPT (Break Pressure Tank) was also 9.5 L/sec, indicating no major leakage from the transmission pipe.
- There was about 9.5 L/sec of leakage from a damaged part of the broncaptering. As the damaged part was repairable with simple concrete patch works, PDAM Sumbawa explained that they will repair it during the coming dry season.
- Total of 19 L/sec will be available for the existing water supply system if the damaged part is repaired to restore the water flow to the system to the original level of 20 L/sec.
- It was also confirmed by the Basic Design Study that the present water supply to Labuhan Mapin is 7.9 L/sec. That exceeds the required water flow to the designed scheme by the Development Study (2002).
- On the other hand, the Team observed leakage from distribution pipes, illegal connections by-passing flow meters, unclosed water taps wasting water, and other forms of wastage.

From the above observations the basic design study concludes that development of new water sources is not justifiable. Rather than that, proper operation and maintenance of the water supply system, including repairing the leaking pipes, banning illegal connections and, accepting adequate metering regulations will solve the impending problem of insufficient water.

Spring water discharge has been smaller than before due to illegal forest cutting. To preserve spring water as a resource, it is necessary to stop such an illegal act.

(2) Water Quality

Out of the nine (9) water supply schemes, water quality analysis was carried out for the following three systems, for which the preceding preparatory study pointed out the necessity for further investigation on water sources.

- Duman (Upper)
- Bagik Papan
- Labuhan Mapin

Water samples taken from the water sources by the team were sent to a laboratory immediately after the sampling. The result of the water quality analysis is shown in Table A1-2 together with the results of the other six (6) systems for which water quality analysis had already been carried out by the development study (2002). The reports from the laboratory for the water samples analyzed for the Basic Design Study are also attached.

a. Water quality evaluation as drinking water

The Indonesian guidelines for drinking water quality are also shown in the Table A1-2.

The table shows that all the analyzed samples are within the Indonesian guidelines for drinking water quality except for bacteria and coliform.

b. Hydrogeological interpretation

In addition to the water quality analysis for drinking water, hydro-geological interpretation was carried out using the following items.

- Cation: Na, K, Ca, Mg

- Anion : Cl, HCO_3, CO_3, SO_4

Analyzed results were converted from milligram per liter (mg/L) to milli-equivalent per liter, thereafter plotted on a 'Trilinear diagram' and 'Stiff diagram' as shown in Figure A1-1 and Figure A1-2 respectively.

1) Figure A1-1 Trilinear diagram shows all the water plots within the domain-I that represents water circulating near the ground surface, including surface water.
2) Figure A1-2 Stiff diagram shows two typical patterns; (1) water from Labuhan Mapin and Tarus show a similar pattern (pattern-A), (2) the others show the a second similar pattern (pattern-B). Pattern-A, which is strongly affected by the carbonated aquifer, is grouped in the Ca-HCO_3 type.
   - It is considered that the springs of Labuhan Mapin and Tarus originate from limestone aquifers, and the aquifers are being relatively quickly recharged by surface water.
   - The other water sources originate from very shallow aquifers, which are directly recharged by surface water. Water flow of those water sources may be strongly affected by rainfall.

Table A1-1 Summary of Survey on Water Sources

System (Village)	Kabpaten (District)	Water Sources	Volume （Measurement method）	Remarks
Kuranji	Lombok Barat	Existing PDAM transmission pipe	-	Residual Chlorine,(0.2 mg/L), Pressure (0.15MPa)
Bajur		Existing PDAM transmission pipe	-	Residual Chlorine,(0.3 mg/L), Pressure (0.32MPa, 0.40 MPa)
Sunbung		Existing PDAM transmission pipe	-	Residual Chlorine,(0.4 mg/L), Pressure (0.48MPa)
Duman (U)		M.A. Kohoh Bukit Trawasan (U)	3.0 L/sec （weight）	200m upstream from the existing broncaptering
		M.A. for Keban Baru	1.4 L/sec （weight）	On a brook of the right flank 150 m upstream of Kohoh Bukit Trawasan (Upper)
Duman (D)		Existing PDAM transmission pipe	-	Residual Chlorine,(0.1 mg/L), Pressure (> 0.32MPa)
Bagik Papan	Lombok Timur	M.A. Balas-I	7 L/sec （current meter）	About 800m upstream of the existing broncaptering
Selaparang		M.A. Lenon	Over 50 L/sec (Development Study)	-
Labuhan Mapin	Sumbawa	M.A. Remas	9.5 L/sec （weigh）	Measured at no.6 BPT
			19 L/sec (weight)	Measured at broncaptering 9.5L/sec is used, the rest 9.5 L/sec is leaking from a broken part。
Tarus	Kupan	M.A.Tarus	About 33 L/sec after pumped by PDAM (current meter, overflowing height）	Measured at the spring It is said that total spring ranges from 40 to 75 L/sec, out of which PDAM uses 15～20 L/sec

Table A1-2 Results of Water quality Analysis

Village	Measured in site								Health-related Item											Hydrogeology-related Item									
Village	T(℃)	pH	EC	NH4	NO3	NO2	Bacteria	T.Coliform	Cr	Fl	As	Pb	Se	Hg	CN	Fe	Cd	Mn	Cu	Na	K	Ca	Mg	Cl	HCO3	SO4	SiO4	Total Hardness as CaCO3	Note
			(mS/m)	(mg/L)	(mg/L)	(mg/L)	colony		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
Labuhan Mapin (No.6BPT)	24.2	7.7	34.1	0.0	0.0	0.0	30.0	D	<0.01	0.1	<0.005	<0.005	<0.005	<0.001	<0.01	<0.01	<0.001	<0.01	<0.02	11.7	<0.02	45.1	11.2	3.9	202.0	6.8	26.7	158.7	Analysis by Basic Design Study
Labuhan Mapin (MA Remas)	22.0	7.4	34.7	0.0	0.0	0.0	30.0	D	<0.01	0.0	<0.005	<0.005	<0.005	<0.001	<0.01	<0.01	<0.001	<0.01	<0.02	10.5	<0.02	43.0	10.2	3.7	205.1	6.8	79.7	149.6	
Duman（Upper）	22.0	7.8	6.7	0.0	0.0	0.0	30.0	D	<0.01	0.2	<0.005	<0.005	<0.005	<0.001	<0.01	0.1	<0.001	<0.01	<0.02	5.9	<0.02	4.1	1.3	3.3	29.0	0.9	13.2	15.5	
Bagik Papan	21.0	7.4	29.0	0.0	0.0	0.0	30.0	D	<0.01	0.5	<0.005	<0.005	<0.005	<0.001	<0.01	<0.01	<0.001	<0.01	<0.02	19.1	<0.02	22.7	11.9	5.1	156.0	5.0	49.4	105.6	
Kuranji Bajur	28.2	7.1	11.6	2.5	2.5	0.1	0.0	ND	<0.006	0.1	<0.001	<0.01	<0.007	<0.001	<0.01	<0.04	<0.005	<0.02	<0.03	8.9	4.3	5.5	3.4	0.0	84.6	<0.94	54.8	27.9	Analysis by Development Study
Sunbung	28.3	7.0	11.8	0.0	2.5	0.0	0.0	ND	<0.006	0.1	<0.001	<0.01	<0.007	<0.001	<0.01	<0.04	<0.005	<0.02	<0.03	8.4	4.0	5.6	3.5	0.0	75.6	2.3	55.5	28.6	
Selaparan	22.1	6.6	16.0	<0.1	2.0	<0.02	25.0	ND	<0.006	0.2	<0.001	<0.01	<0.007	<0.001	<0.01	<0.04	<0.005	<0.02	<0.03	8.7	3.4	9.7	4.9	4.8	56.4	2.8	29.0	44.6	
Duman（Lower）	25.2	6.7	14.8	0.0	4.0	0.0	0.0	ND	<0.006	0.4	<0.001	<0.01	<0.007	<0.001	<0.01	<0.04	<0.005	<0.02	<0.03	10.2	6.1	6.9	4.7	2.3	96.1	<0.94	58.0	36.6	
Tarus	27.9	6.9	53.1	<0.1	5.0	<0.02	>100	D	<0.006	0.1	<0.001	<0.01	<0.007	<0.001	<0.01	<0.04	<0.005	<0.02	<0.03	20.5	1.3	79.9	2.8	7.2	335.4	4.3	9.0	210.9	
Potable Water Guideline Indonesia	-	-	-	-	10.0	1.0	-	ND	0.05	1.40	0.05	0.05	0.01	0.00	0.10	0.30	0.005	0.10	1.00	200	-	-	-	250	-	400	-	-	

＊ND:Non Detected Ｄ:Detected

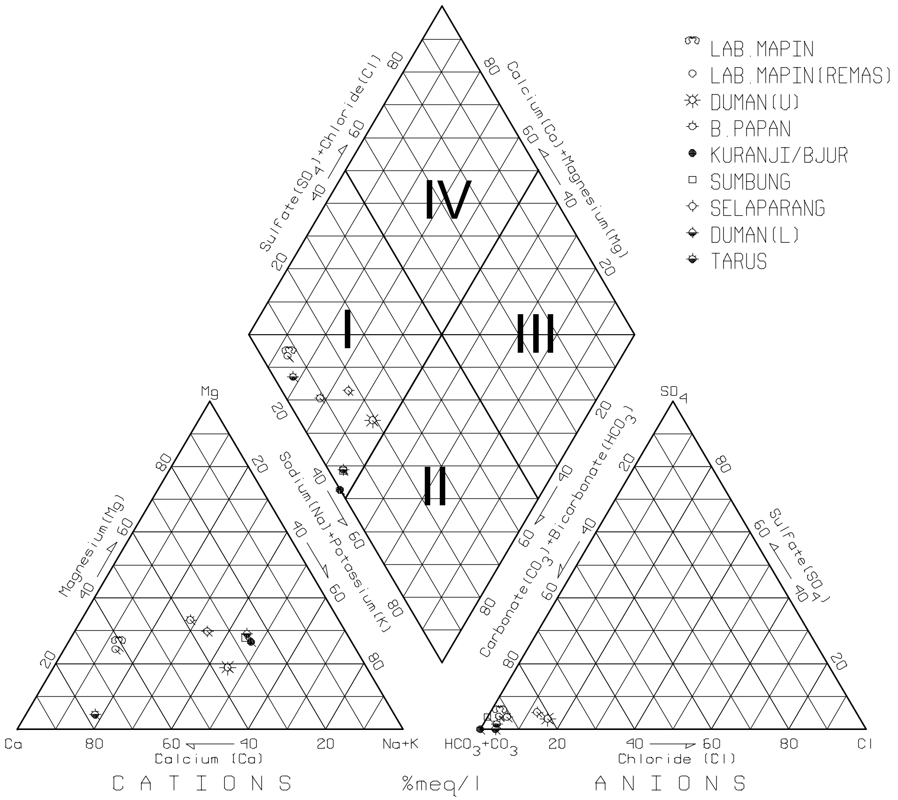


Figure A1-1 Trilinear Diagram

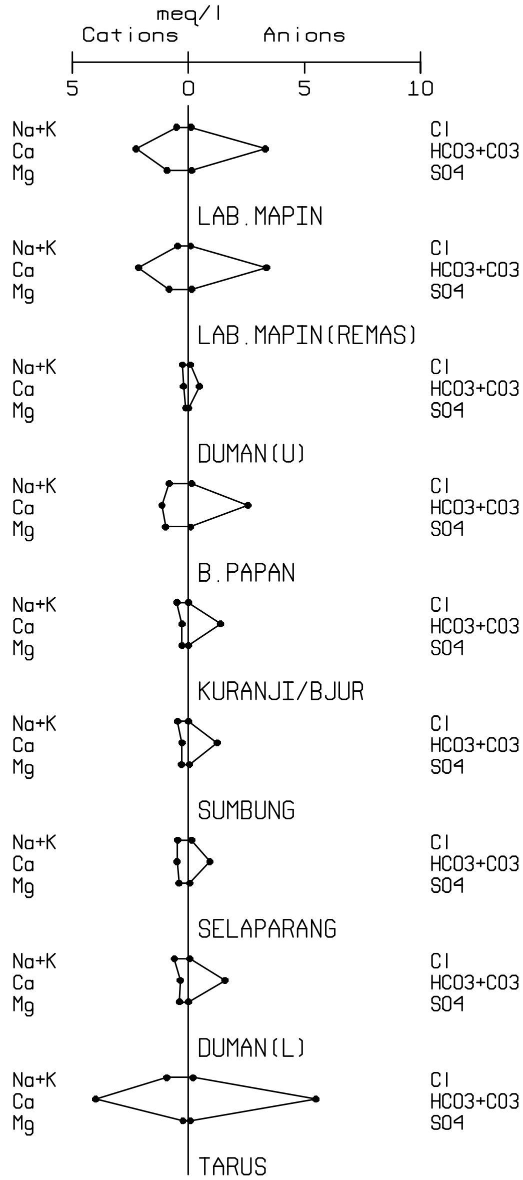


Figure A1-2 Stiff Diagram

Appendix-5.4

Social Condition Survey

5.4 Social Condition Survey

(1) Summary of the Interview Survey

1) General description of interview survey

An interview survey was conducted to verify the willingness to pay (WTP) for water fees on the improved water supply in three villages (Duman Upper, Bagik Papan, and Selaparang) that were pointed out in preparatory study report. The interview survey was contracted to a local consultant firm. The survey was carried out through interview style based on the Contingent Valuation Method (CVM). The collections of data were done using a structured questionnaire. The householder was asked how much he or she was willing to pay for a given level of service on the improved water supply. The collected data were analyzed statistically. The questionnaire differs from the usual household survey greatly in that an evaluation scenario was explained. Thus, interviewees were informed about all important aspects, such as the present situation of water supply in a village, the hypothetical situation of the improved water system, and operation and maintenance (O&M) methods of the system. The interviewees were given special impetus to answer honestly by careful explanation to consider whether they would truly be able to pay, or whether there was a possibility that it might become impossible for them to buy necessary items.

2) Sample collection and analysis

The interview survey was conducted in Duman Upper and Bagik Papan where there will be a Type C system (village/water user's association management), and in Selaparang where there will be a Type A system (PDAM management).

Table B1-1 Sample Size (CVM)

Province	District	Village	Type	House Connection	Public Tap	Total
NTB	Lombok Barat	Duman Upper		126	126	252
	Lombok Timur	Bagik Papan	C	126	126	252
		Selaparang	A	125	125	250
Total						754

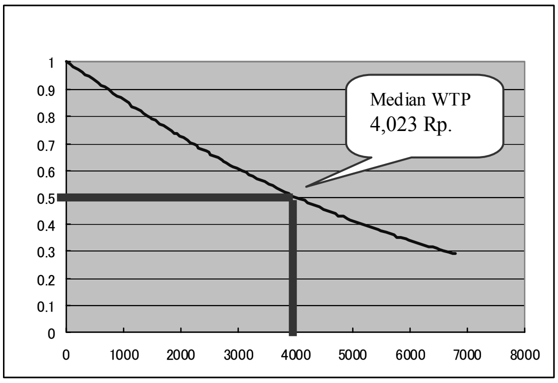
①Duman Upper and Bagik Papan:

In Duman Upper and Bagik Papan, the interview survey was conducted on 252 households in each village. Half of the interviewees (126 households) were asked the amount of WTP in case of public taps and the other half of interviewees (126 households) were asked the same question about house connections. The double-bound model was used to collect data and it offered 5 types of amount (400, 1,000, 1,900, 3,100, 4,600 rupiah) . The double-bound approach adds one follow up question to the single bound question. The amount of WTP was estimated using a Weibull distribution model (The Weibull model is said to have a wide applicability and it makes it easy to obtain a reliable statistical result. The presumed result was estimated by having assumed the Weibull function in the distribution of an amount of WTP.) The result obtained was a very reliable statistic.

The result shows that most people of the village want the improved sanitary water supply system (95%). The amount of WTP is 4,023 rupiah for a house connection system and 2,354 rupiah for public taps in Duman Upper. In Bagik Papan, it is about 1,900 rupiah in each case. Although the amount of O&M fees from each household is not yet estimated, both villages will be able to pay sufficient O&M fees when using the results generated at the time of the development study.

Table B1-2 Water Demand Curve by CVM Method (Duman-upper)

Duman Upper-House Connections
Median WTP: **4,023 Rupiah**
p(significance level) : 0.000***



Duman Upper: Public Taps
Median WTP : **2,354 Rupiah**
p(significance level) : 0.000***

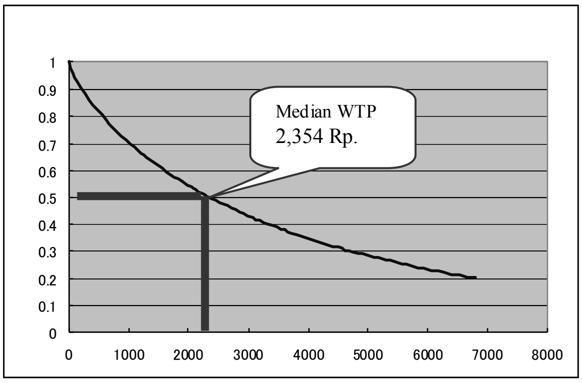
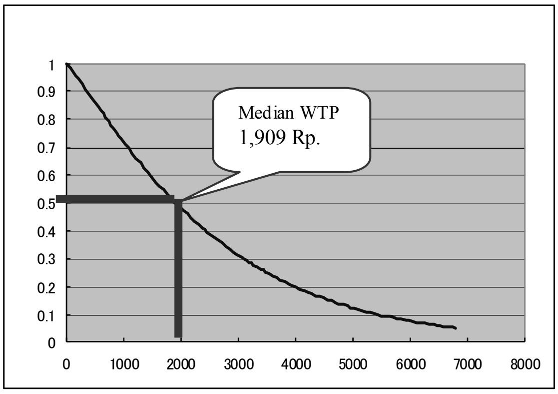
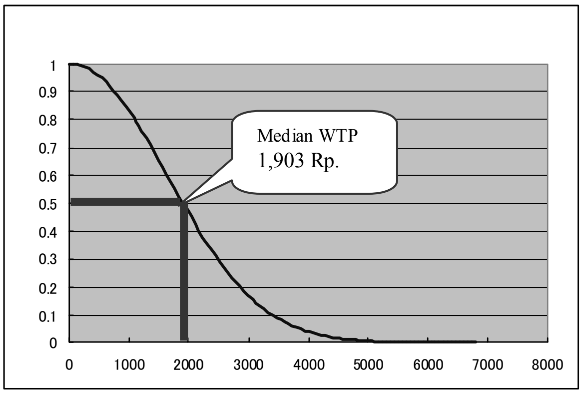


Table B1-3 Water Demand Curve by CVM Method (Bagik Papan)

Bagik Papan- House Connections
Median WTP:1,909 Rupiah
p(significance level) : 0.000***



Bagik Papan- Public Taps
Median WTP : 1,903 Rupiah
p(significance level) : 0.000***



In Bagik Papan, although many households are willing to pay more O&M fees for house connections than public taps, the medium WTP is almost the same at 1,900 rupiah. The following three reasons are mentioned for the cheaper amount of the WTP; 1) Except for one hamlet, there is access to water such as using shallow wells, irrigation channels or springs, despite unsanitary conditions. 2) A common reason that it cannot be paid is that he or she could not afford to pay, even though they understood the importance of O&M. 3) Most of the households are poor and daily seasonal labor. Moreover, because of poverty, there is also a high number of migrant male workers in Bagik Papan.

② Selaparang :

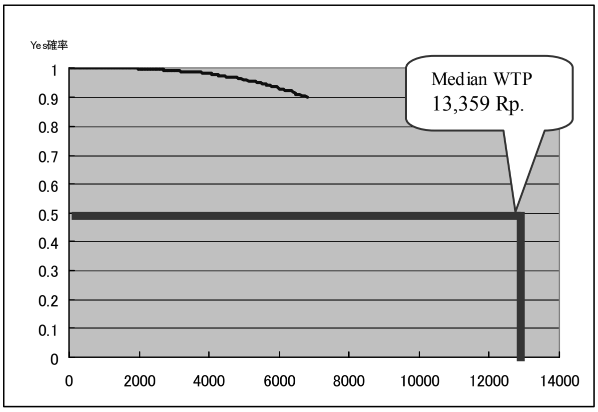
The interview survey was conducted to 250 households in Selaparang. Half of the interviewees (125 households) were asked their WTP for public taps system, and the remaining 125 households were asked the same question for house connections.

In Selaparang, all households want the improved water supply system. First of all, the WTP for house connections was asked on four prepared amounts (4,200, 4,800, 5,400, 6,000 rupiah) that was set up in consideration of the PDAM tariff. Most of the households (99%) answered that they were able to pay. According to the interviewers, households answered that they were able to pay a water charge of more than 10,000 rupiah. At present, households have paid an average 513 rupiah per day for purchasing water, which if converted to a monthly charge is 15,390 rupiah. Therefore, there is no doubt about WTP for house connections in Selaparang. This is because piped water has been supplied only after midnight, although an existing PDAM system is connected. Therefore, households feel very strong stress under the present service, and if there is an improved water supply system, they will pay as much as they can for the water charge.

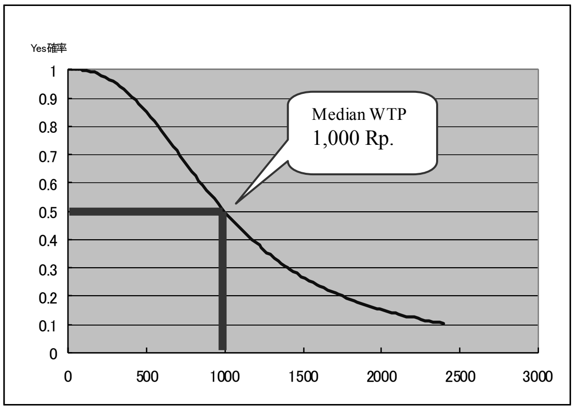
On the other hand, the WTP for public taps was asked for four prepared amounts (1,580, 1,800, 2,000, 2,200 rupiah). In the results, a number of households (78%) answered that they did not want to pay the water fees for public taps. This is because Care International once installed a public tap system for water supply in the community. However, the amount of water was limited and it caused scrambling for water between households. In order to prevent the same problem, many households want to pay for a house connection system rather than a public tap system.

Table B1-4 Water Demand Curve by CVM Method (Selaparang)

Selaparang - House Connections
Median WTP:13,358 Rupiah
p(significance level) : 0.192



Selaparang - Public taps
Median WTP : 1,000 Rupiah
p(significance level) : 0.001***



The result of the estimation was calculated using a logit model. The CVM result for house connections (see left box) shows that the coefficient on this variable is not statistically significant (p-value is larger than 0.1). However, it showed that 124 households out of 125 households would pay and there is no doubt about WTP for house connections. On the other hand, the WTP for public taps was cheaper as 1,000 rupiah, and 97 households out of 125 households did not want to pay because of the above-mentioned reasons.

(2) Baseline Survey of the Community

1) General description of the baseline survey

The baseline survey was conducted to collect baseline data on the socio-economic conditions in the project site. The baseline survey was contracted by a local consultant firm. The survey was conducted at nine (9) systems in eight (8) project villages in the entire project site. Only a baseline survey was carried out this time, since the more detailed socio-economic survey was conducted during the development study. The survey was to randomly cover at lease 20 households at each site as listed below.

Table B2-1 Number of Survey Samples (Baseline Survey)

Survey area：9 systems in 8 project villages

Province	District	village	Number of Household in area to be served (2001)	No. of Samples
NTB	Lombok Barat	Kuranji	441	20
		Bajur	1,230	30
		Sumbung	449	25
		Duman (upper)	809	25
		Duman (lower)	147	20
	Lombok Timur	Bagik Papan	647	25
		Selaparang	663	25
	Sumbawa	Labuhan Mapin	634	25
NTT	Kupang	Tarus	603	20
Total			5,622	215

2) Results of the baseline survey

A brief summary of the results of the baseline survey is shown in Table B2-2. The detailed results of the baseline survey were prepared for each village. In the targeted villages, households use different water sources for drinking and washing purposes. Therefore, in many cases, they do not see the quality of drinking water as a problem, but washing water is felt to be dirty. Most of the households are dissatisfied with water quantity. Especially in the dry season, many people have to walk a long distance to fetch water from a spring or river. It makes women, who have the primary responsibility for water collection, become overworked. According to the incidence rate at the health center, the incidence of water born disease is higher in the dry season. There are not sufficient amounts of water during the dry season. Many people do not like the present facilities and would prefer an improved sanitary water supply system. Most of the households (100% in Kupang, Sumbawa and Lombok Barat, and more than 80% in Lombok Timur) are willing to pay for water fees for an improved water supply system. However, the amount of the WTP was slightly lower than the result of CVM method. This is because the households were asked directly about WTP, "how much can you pay?" without informing them about all the important aspects such as the plan of the water supply system, detailed explanations of the O&M fees and usages of expenses, and importance of health and hygiene. Therefore households will be more willing to pay water fees through a deepening understanding of the new water supply system, water fees, importance of O&M activities and hygiene. According to the World Bank's 'rule of thumb', the cost of water should not exceed 3% of total household income or expenditure. The 3% of household income and expenditure was estimated and shown in the table. Accordingly, the PDAM tariffs and the O&M costs will be financially affordable by the households.

Table B2-2 Baseline Survey Data

Item	Unit	Kuranji	Bajur	Sumbung	Duman Upper	Duman Lower	Bagik Papan	Selaparang	Labuhan Mapin	Tarus
No. of household	Person	4.05	4.7	4.68	4.92	5.05	4.6	4.84	4.92	5.35
Children : Adult		48:52	39:61	35:65	45:55	39:61	47:53	45:55	47:53	51:49
Occupation		Trading Wage la b.	Trading Agri.rice	Wage lab Agri rice	Agricultur e	Agri rice Trading	Agri lab Agri rice	Agriculture Rice	Fishery	Trading Wage lab
Cattle	% household	0	0	0	0	0	4	0	24	0
Goats / sheep	% household	0	0	0	0	0	8	12	16	0
Poetry	% household	50	30	88	64	50	56	32	32	55
Ave. hhd. Income	Rupiah/month/hhd	320,855	537,628	358,640	410,105	381,679	813,536	1,019,669	440,896	410,150
Ave. hhd. Expenditure	Rupiah/month/hhd	611,743	846,932	626,982	938,856	648,503	1,113,383	1,429,521	491,186	598,050
Water purchase	% household	5%(1/20)	3%(1/30)	4%(1/25)	28%(7/25)	5%(1/20)	28%(7/25)	52%(13/25)	44%(11/25)	20%(4/20)
Water fees	Rupiah/month/hhd	10,000	15,000	13,333	3,214	20,000	7,714	31,038	37,568	80,000
Tobacco payment	Rupiah/month/hhd	44,867	103,889	71,289	19,813	77,597	45,083	77,433	75,357	62,222
Possession rate of TV	%	35	70	60	44	40	56	56	40	100
Ave no of collection	times/day	6	5	6	6	5	4	5	11	9
Water source for Drinking		Well 65% HC 30%	Well 97% Parch. 3%	Well 76% Spring 20% PT 4%	PT 100% River user	Well 70% Spring 25% Purch 5%	PT 100%	HC 56% PT 44%	PT 48% HC 35% Well 17%	Well 65% Purch 20% River 10% HC 5%
Water source for washing		Well 10 0%	Well 10 0%	Spring 5 6% PT 24% Well 20%	PT 56% River 44%	Well45% Spring40% River15%	River 100%	River 76% HC 12% PT 12%	PT 45% HC 41% Well 9% River 5%	Well 42% River 37%
Ave. distance to water (rainy season)	meter	14m	5m	5m	68m	68m	109m	2m	172m	195m
Ave. distance to water (dry season)	meter	18m	6m	195m	706m	243m	116m	24m	172m	195m
Quantity of Water	Satisfaction %	0%	0%	0%	36%	0%	0%	0%	37%	100%
Quality of Water	Satisfaction %	95%	100%	100%	64%	83%	PT 100% River 0%	PT 100% River 0%	PT 0% Well 0%	82%
Needs of improved facility	Necessity %	90%	90%	88%	80%	80%	100%	100%	100%	100%
Willingness to Pay	%	80%	90%	84%	80%	78%	88%	96%	100%	100%
Amount of WTP	Rupiah/month/hhd	2,167	2,688	2,381	1,690	4,321	1,909	3,333	7,190	11,225
3% of estimated Income	Rupiah/month/hhd	9,626	16,129	10,759	12,303	11,450	24,406	30,590	13,227	12,305
3% of estimated Expenditure	Rupiah/month/hhd	18,352	25,408	18,809	28,166	19,455	33,401	42,886	14,736	17,942
Boil water before drinking	Yes %	20%	60%	52%	35%	35%	72%	84%	56%	100%

PT:Public Tap

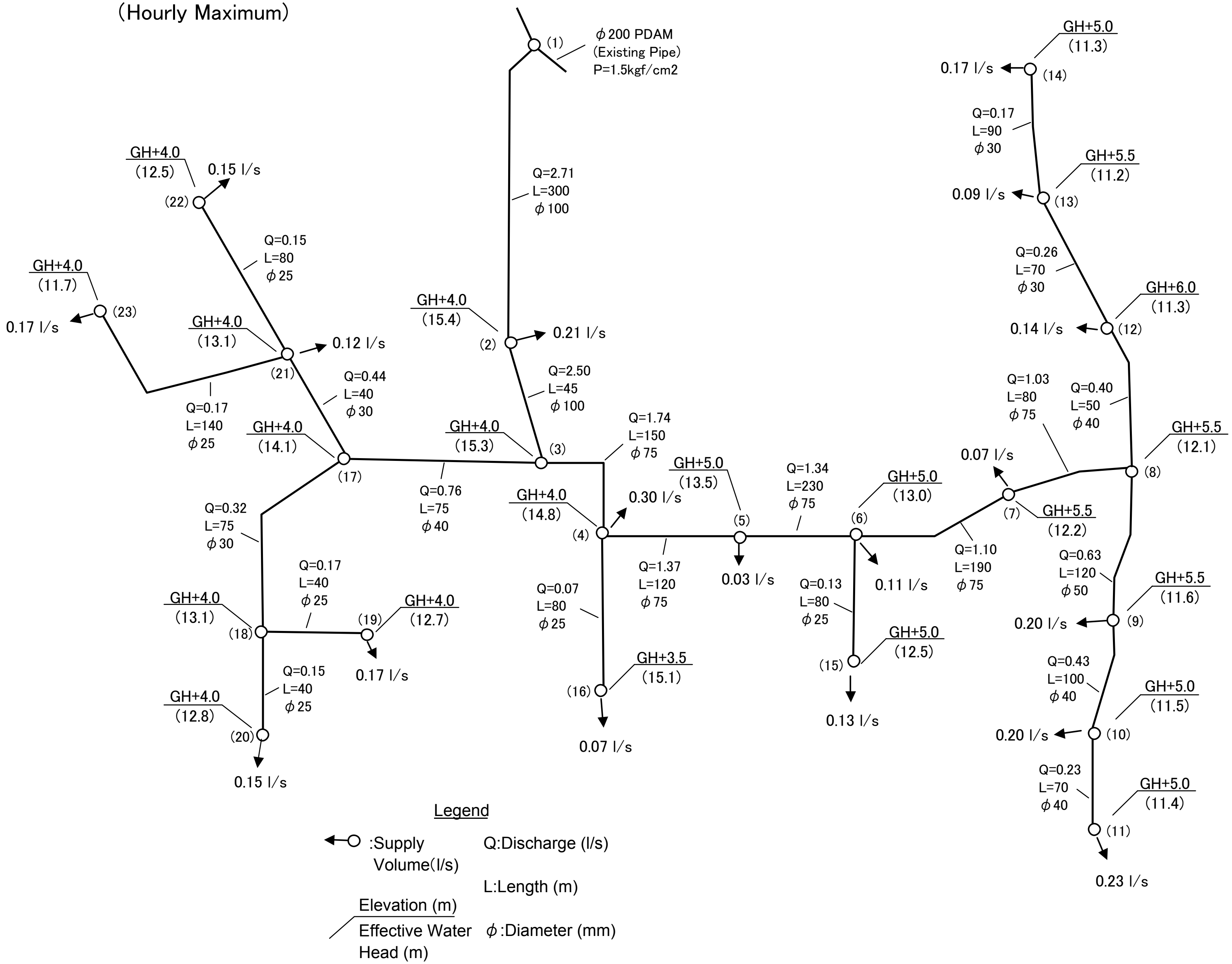
HC:House Connection

Appendix-5.5

Distribution Network Analysis

KURANJI

(Hourly Maximum)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 1 Kuranji
Route: Distribution Pipeline

HYDRAULIC CALCULATION

Hazen-Williams' formula

Case: Hourly Maximum

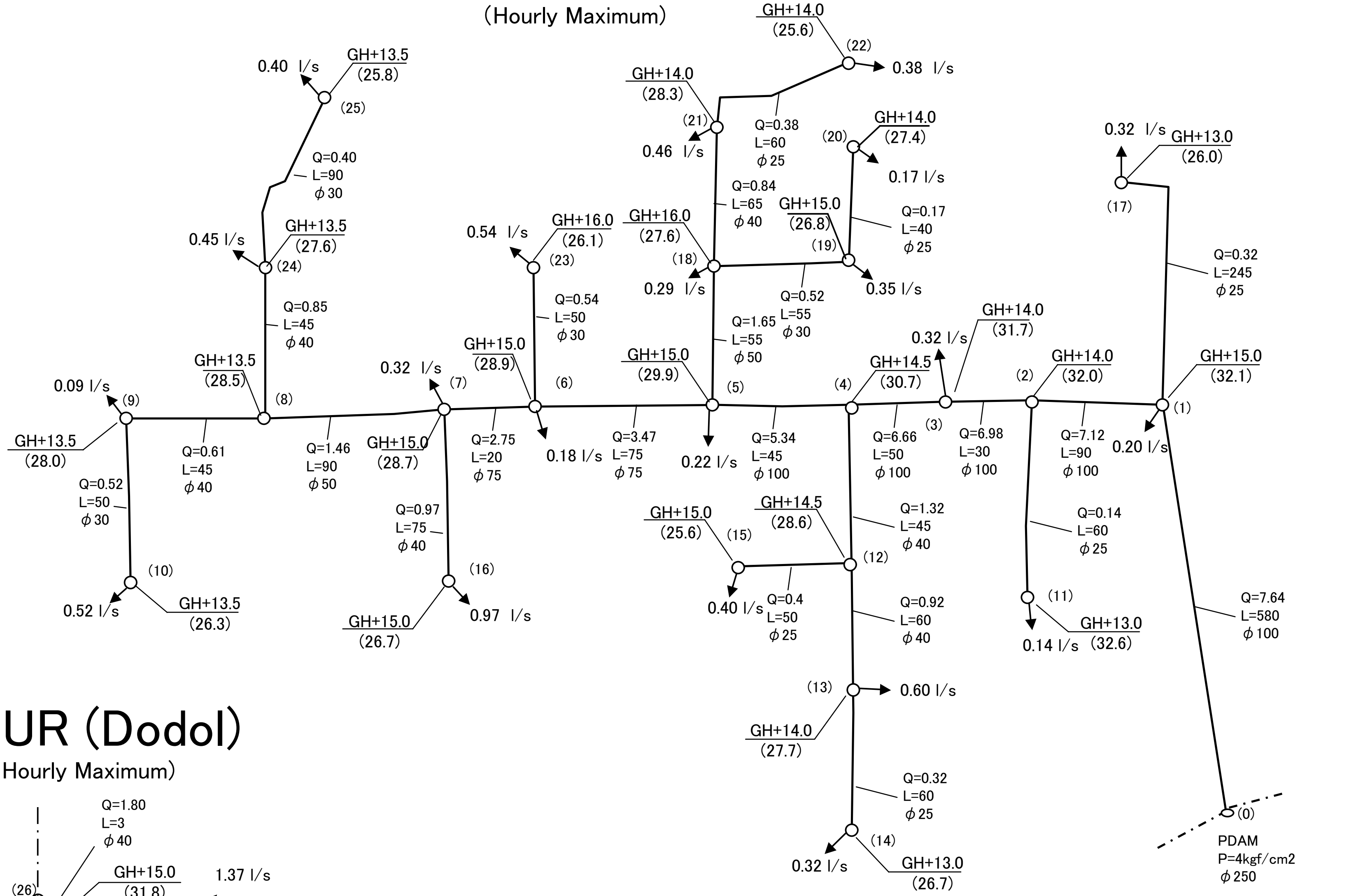
Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h(m)	H (m)	h(m)	he (m)	Note
PDAM Distribution Pipe									20.0			GL(5.0+1.5kg/cm^2)
1 − 2	100	120	0.21	2.71	300	0.345	2.0	0.6	19.4	4.0	15.4	
2 − 3	100	120	0.00	2.50	45	0.318	1.7	0.1	19.3	4.0	15.3	
3 − 4	75	120	0.30	1.74	150	0.394	3.6	0.5	18.8	4.0	14.8	
4 − 5	75	120	0.03	1.37	120	0.310	2.3	0.3	18.5	5.0	13.5	
5 − 6	75	120	0.11	1.34	230	0.303	2.2	0.5	18.0	5.0	13.0	
6 − 7	75	120	0.07	1.10	190	0.249	1.5	0.3	17.7	5.5	12.2	
7 − 8	75	120	0.00	1.03	80	0.233	1.4	0.1	17.6	5.5	12.1	
8 − 9	50	120	0.20	0.63	120	0.321	3.9	0.5	17.1	5.5	11.6	
9 − 10	40	120	0.20	0.43	100	0.342	5.8	0.6	16.5	5.0	11.5	
10 11	40	120	0.23	0.23	70	0.183	1.8	0.1	16.4	5.0	11.4	
8 − 12	40	120	0.14	0.40	50	0.318	5.1	0.3	17.3	6.0	11.3	
12 − 13	30	120	0.09	0.26	70	0.368	9.2	0.6	16.7	5.5	11.2	
13 − 14	30	120	0.17	0.17	90	0.241	4.2	0.4	16.3	5.0	11.3	
6 − 15	25	120	0.13	0.13	80	0.265	6.2	0.5	17.5	5.0	12.5	
4 − 16	25	120	0.07	0.07	80	0.143	2.0	0.2	18.6	3.5	15.1	
3 − 17	40	120	0.00	0.76	75	0.605	16.6	1.2	18.1	4.0	14.1	
17 − 18	30	120	0.00	0.32	75	0.453	13.6	1.0	17.1	4.0	13.1	
18 19	25	120	0.17	0.17	40	0.346	10.2	0.4	16.7	4.0	12.7	
18 − 20	25	120	0.15	0.15	250	0.306	8.1	2.0	15.1	4.0	11.1	
17 − 21	30	120	0.12	0.44	40	0.622	24.5	1.0	17.1	4.0	13.1	
21 − 22	25	120	0.15	0.15	80	0.306	8.1	0.6	16.5	4.0	12.5	
21 − 23	25	120	0.17	0.17	140	0.346	10.2	1.4	15.7	4.0	11.7	

Remarks:

d :	Pipe diameter	I :	Hydraulic gradient
C :	Flow velocity coefficient	⊿h :	Loss head
q :	Discharge	H :	Dynamic water level
Q :	Flow rate	h :	Ground elevation
L :	Length of pipeline	he :	Effective head
V :	Velocity		

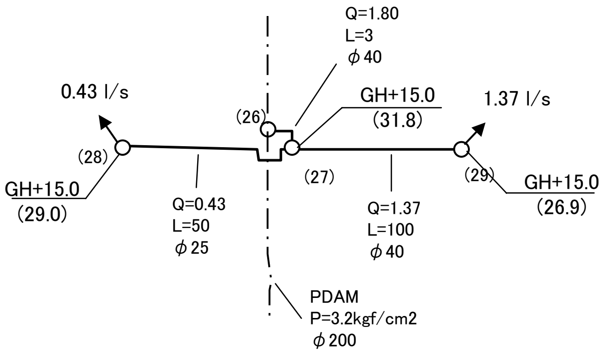
BAJUR

(Hourly Maximum)



BAJUR (Dodol)

(Hourly Maximum)



Legend

:Supply Volume (l/s)

Q:Discharge (l/s)

L:Length (m)

Elevation (m)

Effective Water Head (m)

φ:Diameter (mm)

Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 2.1 Bajur
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen–Williams' formula

Node No.			d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h (m)	H (m)	h(m)	he (m)	Note
PDAM Distribution Pipe											55.0			GL..15m+4.0kg/cm^2
0	–	1	100	120	0.20	7.64	580	0.973	13.7	7.9	47.1	15.0	32.1	
1	–	2	100	120	0.00	7.12	90	0.907	12.0	1.1	46.0	14.0	32.0	
2	–	3	100	120	0.32	6.98	30	0.889	11.6	0.3	45.7	14.0	31.7	
3	–	4	100	120	0.00	6.66	50	0.848	10.6	0.5	45.2	14.5	30.7	
4	–	5	100	120	0.22	5.34	45	0.680	7.0	0.3	44.9	15.0	29.9	
5	–	6	75	120	0.18	3.47	75	0.785	12.9	1.0	43.9	15.0	28.9	
6	–	7	75	120	0.32	2.75	20	0.622	8.4	0.2	43.7	15.0	28.7	
7	–	8	50	120	0.00	1.46	90	0.744	18.7	1.7	42.0	13.5	28.5	
8	–	9	40	120	0.09	0.61	45	0.485	11.0	0.5	41.5	13.5	28.0	
9	–	10	30	120	0.52	0.52	50	0.736	33.3	1.7	39.8	13.5	26.3	
2		11	25	120	0.14	0.14	60	0.285	7.1	0.4	45.6	13.0	32.6	
4	–	12	40	120	0.00	1.32	45	1.050	46.0	2.1	43.1	14.5	28.6	
12	–	13	40	120	0.60	0.92	60	0.732	23.6	1.4	41.7	14.0	27.7	
13	–	14	25	120	0.32	0.32	60	0.652	33.0	2.0	39.7	13.0	26.7	
12	–	15	25	120	0.40	0.40	50	0.815	49.8	2.5	40.6	15.0	25.6	
7	–	16	40	120	0.97	0.97	75	0.772	26.0	2.0	41.7	15.0	26.7	
1	–	17	25	120	0.32	0.32	245	0.652	33.0	8.1	39.0	13.0	26.0	
							250							
5	–	18	50	120	0.29	1.65	55	0.840	23.4	1.3	43.6	16.0	27.6	
18	–	19	30	120	0.35	0.52	55	0.736	33.3	1.8	41.8	15.0	26.8	
19	–	20	25	120	0.17	0.17	40	0.346	10.2	0.4	41.4	14.0	27.4	
18	–	21	40	120	0.46	0.84	65	0.668	19.9	1.3	42.3	14.0	28.3	
21	–	22	25	120	0.38	0.38	60	0.774	45.3	2.7	39.6	14.0	25.6	
6	–	23	30	120	0.54	0.54	50	0.764	35.7	1.8	42.1	16.0	26.1	
8	–	24	40	120	0.45	0.85	45	0.676	20.4	0.9	41.1	13.5	27.6	
24	–	25	30	120	0.40	0.40	90	0.566	20.5	1.8	39.3	13.5	25.8	

Remarks:

d :	Pipe diameter	I :	Hydraulic gradient
C :	Flow velocity coefficient	⊿h :	Loss head
q :	Discharge	H :	Dynamic water level
Q :	Flow rate	h :	Ground elevation
L :	Length of pipeline	he :	Effective head
V :	Velocity		

Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 2.2 Bajur(Dodol)
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen-Williams' formula

Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h(m)	H (m)	h(m)	he (m)	Note
PDAM Distribution Pipe									32.0			GL+3.2kg/cm^2
26 － 27	40	120	0.00	1.80	3	1.432	81.6	0.2	31.8	0.0	31.8	
27 － 28	25	120	0.43	0.43	50	0.876	56.9	2.8	29.0	0.0	29.0	
27 － 29	40	120	1.37	1.37	100	1.090	49.3	4.9	26.9	0.0	26.9	

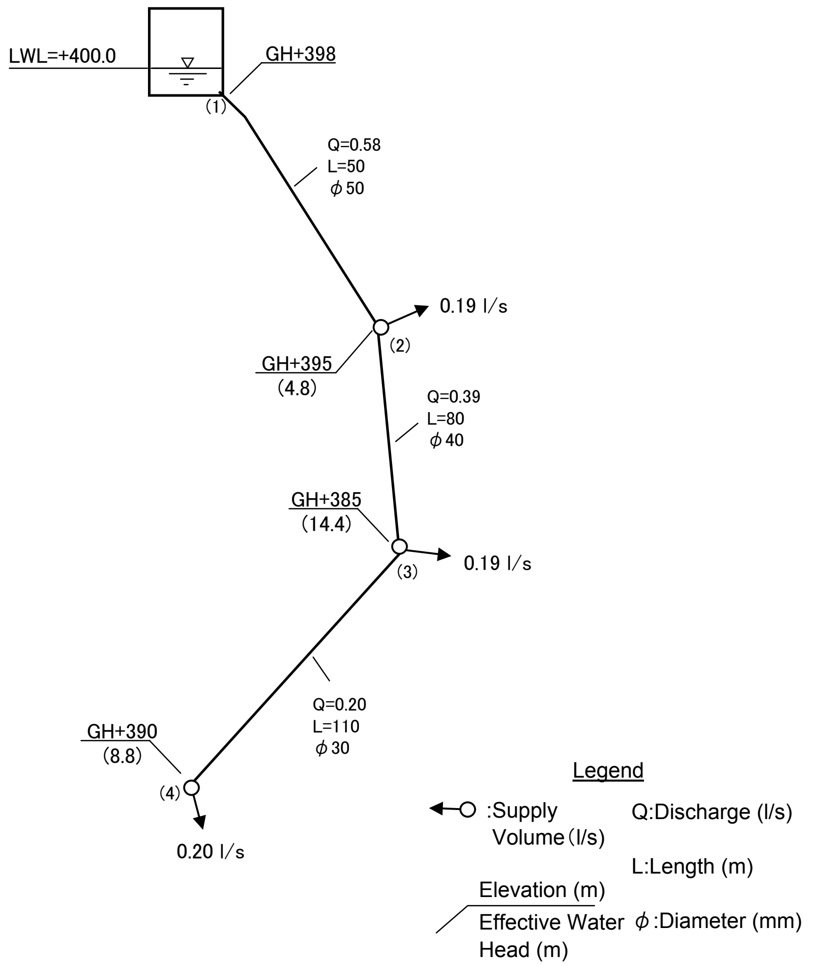
Remarks:

d	:	Pipe diameter	I	:	Hydraulic gradient
C	:	Flow velocity coefficient	⊿h	:	Loss head
q	:	Discharge	H	:	Dynamic water level
Q	:	Flow rate	h	:	Ground elevation
L	:	Length of pipeline	he	:	Effective head
V	:	Velocity			

KUBUN BARU

(Hourly Maximum)

DUMAN UPPER
(1/6)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 4.1 Kubun Baru
Route: Distribution Pipeline

HYDRAULIC CALCULATION

Hazen–Williams' formula

Case: Hourly Maximum

Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h (m)	H (m)	h(m)	he (m)	Note
									400.0	398.0		
1 − 2	50	120	0.19	0.58	50	0.295	3.4	0.2	399.8	395.0	4.8	
2 − 3	40	120	0.19	0.39	80	0.310	4.8	0.4	399.4	385.0	14.4	
3 − 4	30	120	0.20	0.20	110	0.283	5.7	0.6	398.8	390.0	8.8	

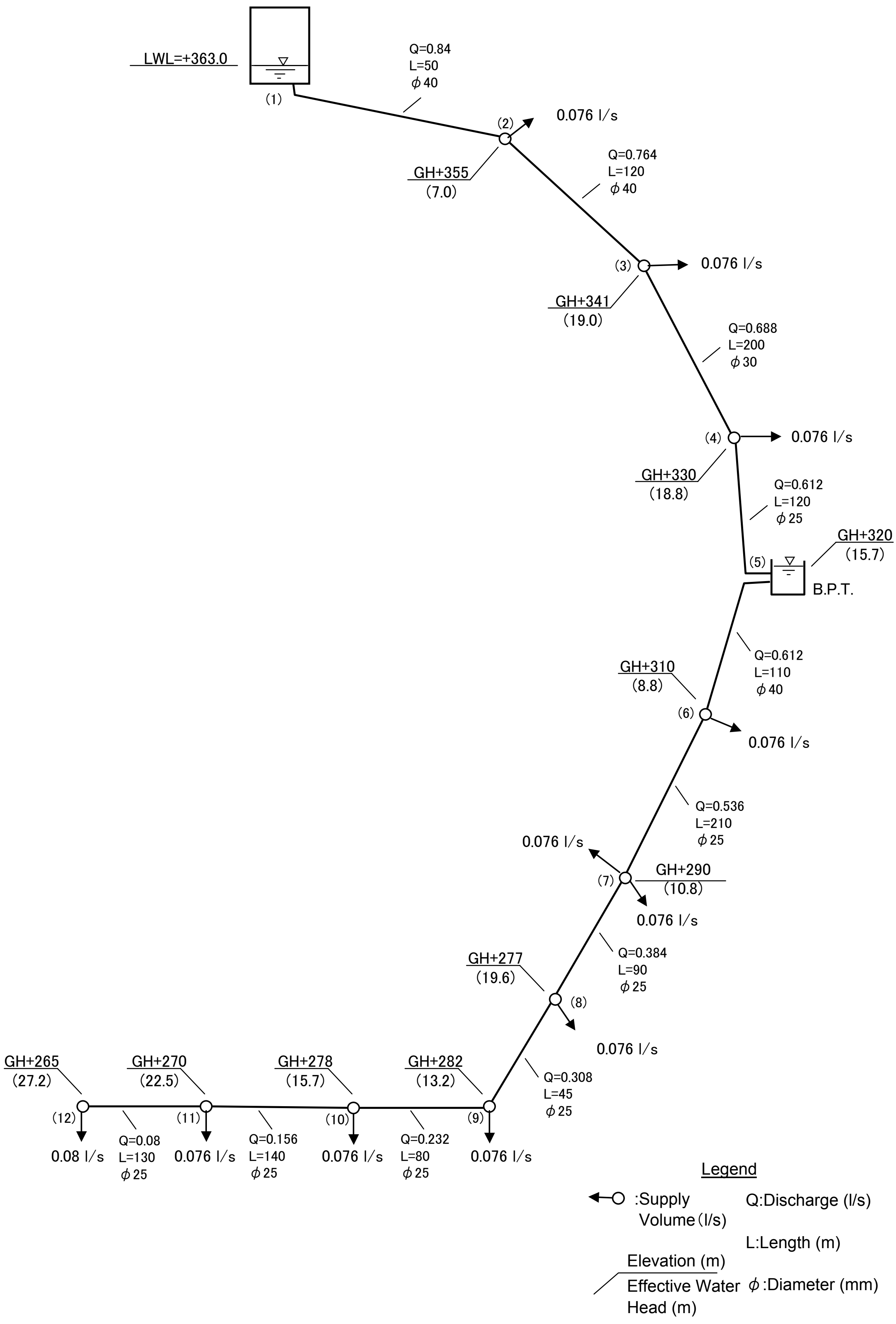
Remarks:

- d : Pipe diameter
- C : Flow velocity coefficient
- q : Discharge
- Q : Flow rate
- L : Length of pipeline
- V : Velocity
- I : Hydraulic gradient
- ⊿h : Loss head
- H : Dynamic water level
- h : Ground elevation
- he : 250

AWANG MADYA

(Hourly Maximum)

DUMAN UPPER
(2/6)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 4.2 Awang Madya
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen-Williams' formula

Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h (m)	H (m)	h(m)	he (m)	Note
									363.0	398.0		
1 − 2	40	120	0.076	0.840	50	0.668	19.9	1.0	362.0	355.0	7.0	
2 − 3	40	120	0.076	0.764	120	0.608	16.7	2.0	360.0	341.0	19.0	
3 − 4	30	120	0.076	0.688	200	0.973	55.9	11.2	348.8	330.0	18.8	
4 − 5	25	120	0.000	0.612	120	1.247	109.4	13.1	335.7	320.0	15.7	BPT
									320.0			BPT
5 − 6	40	120	0.076	0.612	110	0.487	11.1	1.2	318.8	310.0	8.8	
6 − 7	25	120	0.152	0.536	210	1.092	85.6	18.0	300.8	290.0	10.8	
7 − 8	25	120	0.076	0.384	90	0.782	46.2	4.2	296.6	277.0	19.6	
8 − 9	25	120	0.076	0.308	45	0.627	30.7	1.4	295.2	282.0	13.2	
9 − 10	25	120	0.076	0.232	80	0.473	18.2	1.5	293.7	278.0	15.7	
10 − 11	25	120	0.076	0.156	140	0.318	8.7	1.2	292.5	270.0	22.5	
11 − 12	25	120	0.080	0.080	130	0.163	2.5	0.3	292.2	265.0	27.2	

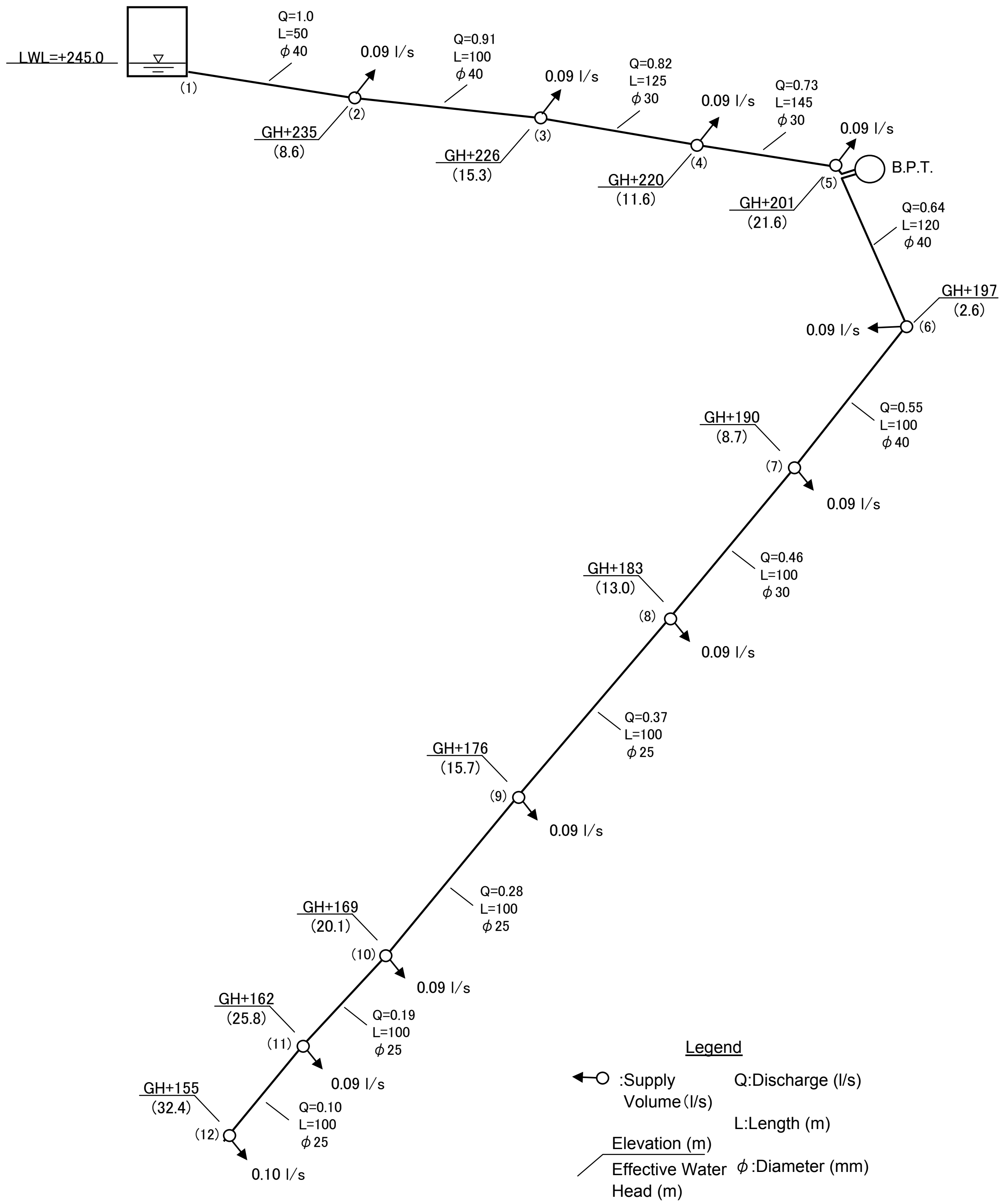
Remarks:

d	:	Pipe diameter	I	:	Hydraulic gradient
C	:	Flow velocity coefficient	⊿h	:	Loss head
q	:	Discharge	H	:	Dynamic water level
Q	:	Flow rate	h	:	Ground elevation
L	:	Length of pipeline	he	:	Effective head
V	:	Velocity			

MONTONG

(Hourly Maximum)

DUMAN UPPER
(4/6)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 4.3 Montong
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen–Williams' formula

Node No.			d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h (m)	H (m)	h(m)	he (m)	Note
											245.0	245.0		
1	−	2	40	120	0.090	1.000	50	0.796	27.5	1.4	243.6	235.0	8.6	
2	−	3	40	120	0.090	0.910	100	0.724	23.1	2.3	241.3	226.0	15.3	
3	−	4	30	120	0.090	0.820	125	1.160	77.4	9.7	231.6	220.0	11.6	
4	−	5	30	120	0.090	0.730	145	1.033	62.4	9.0	222.6	201.0	21.6	BPT
											201.0	201.0		BPT
5	−	6	40	120	0.090	0.640	120	0.509	12.0	1.4	199.6	197.0	2.6	
6	−	7	40	120	0.090	0.550	100	0.438	9.1	0.9	198.7	190.0	8.7	
7	−	8	30	120	0.090	0.460	100	0.651	26.5	2.7	196.0	183.0	13.0	
8	−	9	25	120	0.090	0.370	100	0.754	43.1	4.3	191.7	176.0	15.7	
9	−	10	25	120	0.090	0.280	100	0.570	25.8	2.6	189.1	169.0	20.1	
10	−	11	25	120	0.090	0.190	100	0.387	12.6	1.3	187.8	162.0	25.8	
11	−	12	25	120	0.100	0.100	100	0.204	3.8	0.4	187.4	155.0	32.4	

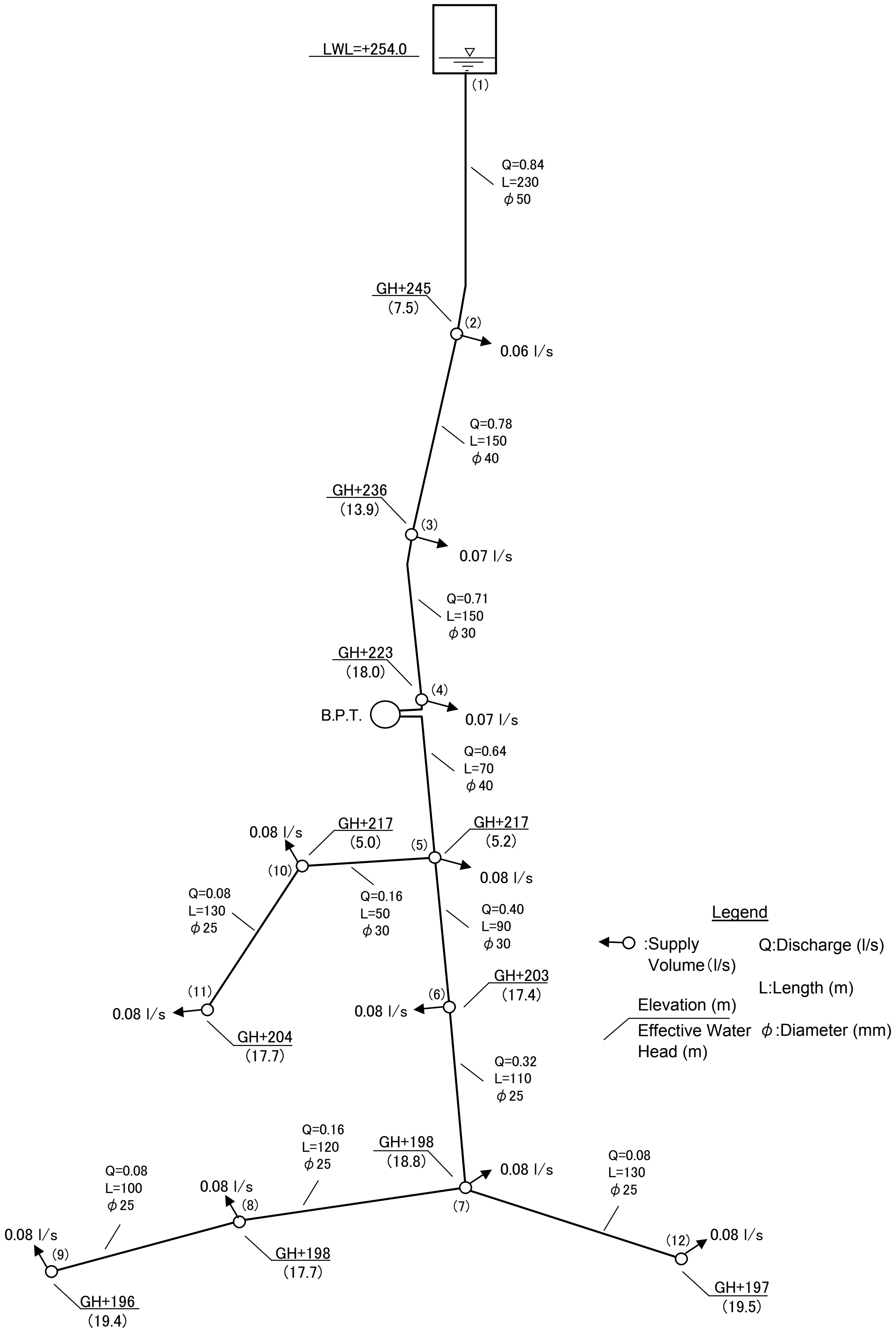
Remarks:

d	:	Pipe diameter	I	:	Hydraulic gradient
C	:	Flow velocity coefficient	⊿h	:	Loss head
q	:	Discharge	H	:	Dynamic water level
Q	:	Flow rate	h	:	Ground elevation
L	:	Length of pipeline	he	:	Effective head
V	:	Velocity			

LEONG

(Hourly Maximum)

DUMAN UPPER
(3/6)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 4.4 Leong
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen−Williams' formula

Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h (m)	H (m)	h(m)	he (m)	Note
									254.0	254.0		
1 − 2	50	120	0.060	0.840	230	0.428	6.7	1.5	252.5	245.0	7.5	
2 − 3	40	120	0.070	0.780	150	0.621	17.4	2.6	249.9	236.0	13.9	
3 − 4	30	120	0.070	0.710	150	1.004	59.3	8.9	241.0	223.0	18.0	BPT
									223.0			
4 − 5	40	120	0.080	0.640	70	0.509	12.0	0.8	222.2	217.0	5.2	BPT
5 − 6	30	120	0.080	0.400	90	0.566	20.5	1.8	220.4	203.0	17.4	
6 − 7	25	120	0.080	0.320	110	0.652	33.0	3.6	216.8	198.0	18.8	
7 − 8	25	120	0.080	0.160	120	0.326	9.1	1.1	215.7	198.0	17.7	
8 − 9	25	120	0.080	0.080	100	0.163	2.5	0.3	215.4	196.0	19.4	
5 − 10	30	120	0.080	0.160	50	0.226	3.8	0.2	222.0	217.0	5.0	
10 − 11	25	120	0.080	0.080	130	0.163	2.5	0.3	221.7	204.0	17.7	
7 − 12	25	120	0.080	0.080	130	0.163	2.5	0.3	216.5	197.0	19.5	

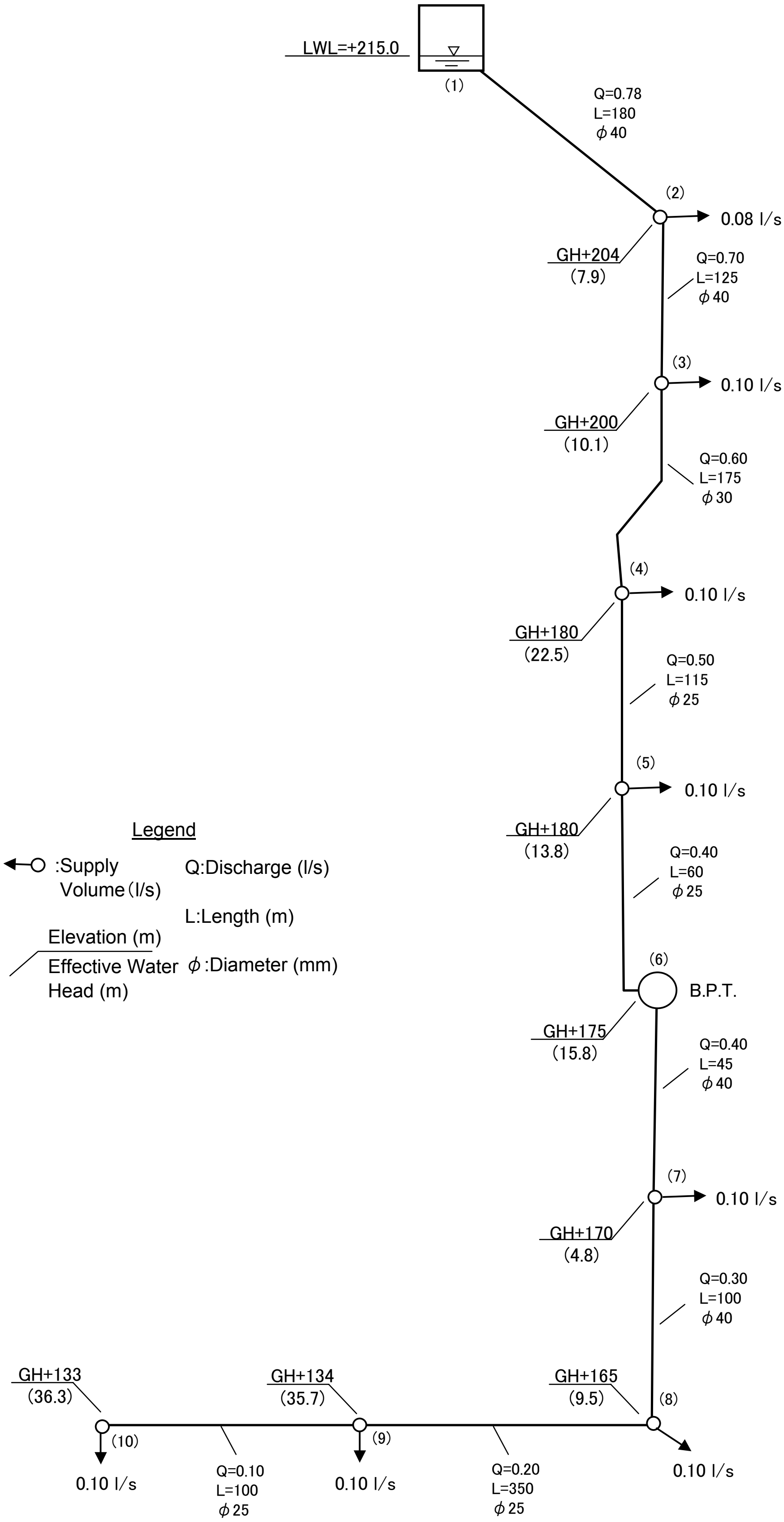
Remarks:

d :	Pipe diameter	I :	Hydraulic gradient
C :	Flow velocity coefficient	⊿h :	Loss head
q :	Discharge	H :	Dynamic water level
Q :	Flow rate	h :	Ground elevation
L :	Length of pipeline	he :	Effective head
V :	Velocity		

DUMAN UTARA

(Hourly Maximum)

DUMAN UPPER
(5/6)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 4.5 Duman Utara
Route: Distribution Pipeline

HYDRAULIC CALCULATION

Hazen−Williams' formula

Case: Hourly Maximum

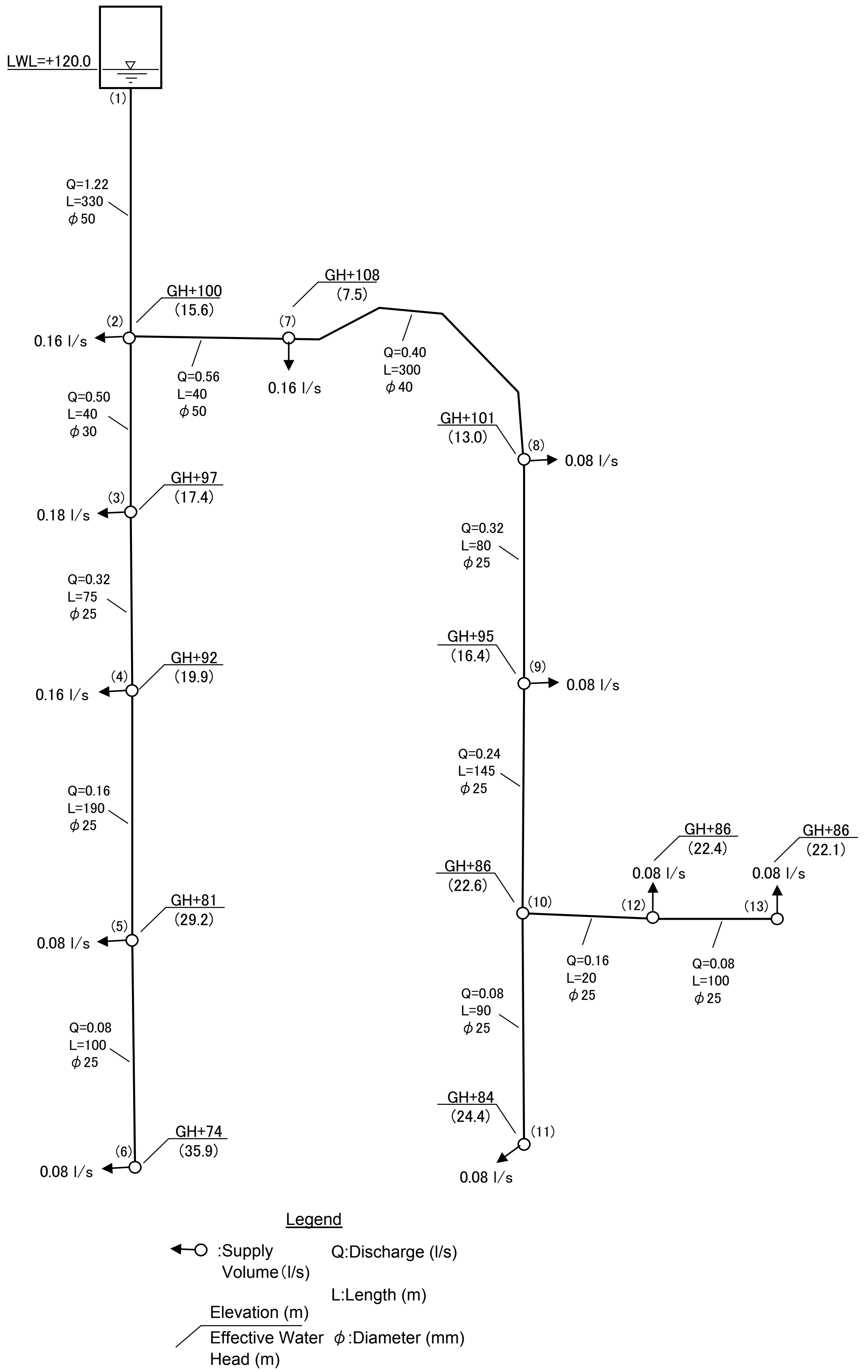
Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h(m)	H (m)	h(m)	he (m)	Note
									215.0	215.0		
1 − 2	40	120	0.080	0.780	180	0.621	17.4	3.1	211.9	204.0	7.9	
2 − 3	40	120	0.100	0.700	125	0.557	14.2	1.8	210.1	200.0	10.1	
3 − 4	30	120	0.100	0.600	175	0.849	43.4	7.6	202.5	180.0	22.5	
4 − 5	25	120	0.100	0.500	115	1.019	75.3	8.7	193.8	180.0	13.8	
5 − 6	25	120	0.000	0.400	60	0.815	49.8	3.0	190.8	175.0	15.8	BPT
									175.0	175.0	0.0	BPT
6 − 7	40	120	0.100	0.400	45	0.318	5.1	0.2	174.8	170.0	4.8	
7 − 8	40	120	0.100	0.300	100	0.239	3.0	0.3	174.5	165.0	9.5	
8 − 9	25	120	0.100	0.200	350	0.407	13.8	4.8	169.7	134.0	35.7	
5 − 10	25	120	0.100	0.100	100	0.204	3.8	0.4	169.3	133.0	36.3	

Remarks:

- d : Pipe diameter
- C : Flow velocity coefficient
- q : Discharge
- Q : Flow rate
- L : Length of pipeline
- V : Velocity
- I : Hydraulic gradient
- ⊿h : Loss head
- H : Dynamic water level
- h : Ground elevation
- he : Effective head

DUMAN DASAN, SERAYA DUMAN

(Hourly Maximum)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 4.6Duman Dasan & Seraya Duman
Route: Distribution Pipeline

HYDRAULIC CALCULATION

Hazen-Williams' formula

Case: Hourly Maximum

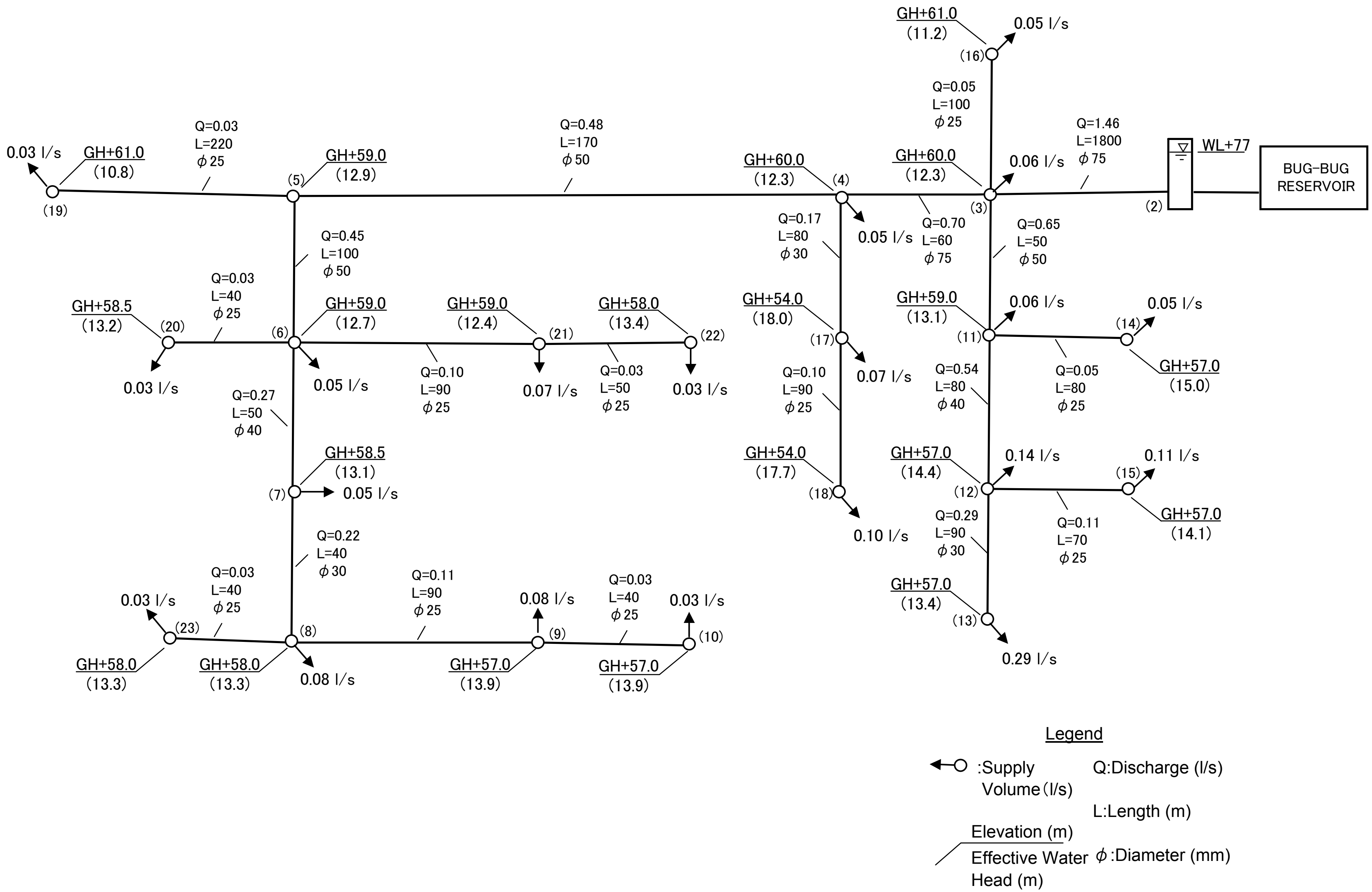
Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h(m)	H (m)	h(m)	he (m)	Note
									120.0	120.0		
1 − 2	50	120	0.160	1.220	330	0.621	13.4	4.4	115.6	100.0	15.6	
2 − 3	30	120	0.180	0.500	40	0.707	31.0	1.2	114.4	97.0	17.4	
3 − 4	25	120	0.160	0.320	75	0.652	33.0	2.5	111.9	92.0	19.9	
4 − 5	25	120	0.080	0.160	190	0.326	9.1	1.7	110.2	81.0	29.2	
5 − 6	25	120	0.080	0.080	100	0.163	2.5	0.3	109.9	74.0	35.9	
2 − 7	50	120	0.160	0.560	40	0.285	3.2	0.1	115.5	108.0	7.5	
7 − 8	40	120	0.080	0.400	300	0.318	5.1	1.5	114.0	101.0	13.0	
8 − 9	25	120	0.080	0.320	80	0.652	33.0	2.6	111.4	95.0	16.4	
9 − 10	25	120	0.000	0.240	145	0.489	19.4	2.8	108.6	86.0	22.6	
10 − 11	25	120	0.080	0.080	90	0.163	2.5	0.2	108.4	84.0	24.4	
10 − 12	25	120	0.080	0.160	20	0.326	9.1	0.2	108.4	86.0	22.4	
12 − 13	25	120	0.080	0.080	100	0.163	2.5	0.3	108.1	86.0	22.1	

Remarks:

d :	Pipe diameter	I :	Hydraulic gradient
C :	Flow velocity coefficient	⊿h :	Loss head
q :	Discharge	H :	Dynamic water level
Q :	Flow rate	h :	Ground elevation
L :	Length of pipeline	he :	Effective head
V :	Velocity		

DUMAN LOWER

(Hourly Maximum)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 5 Duman Lower
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen-Williams' formula

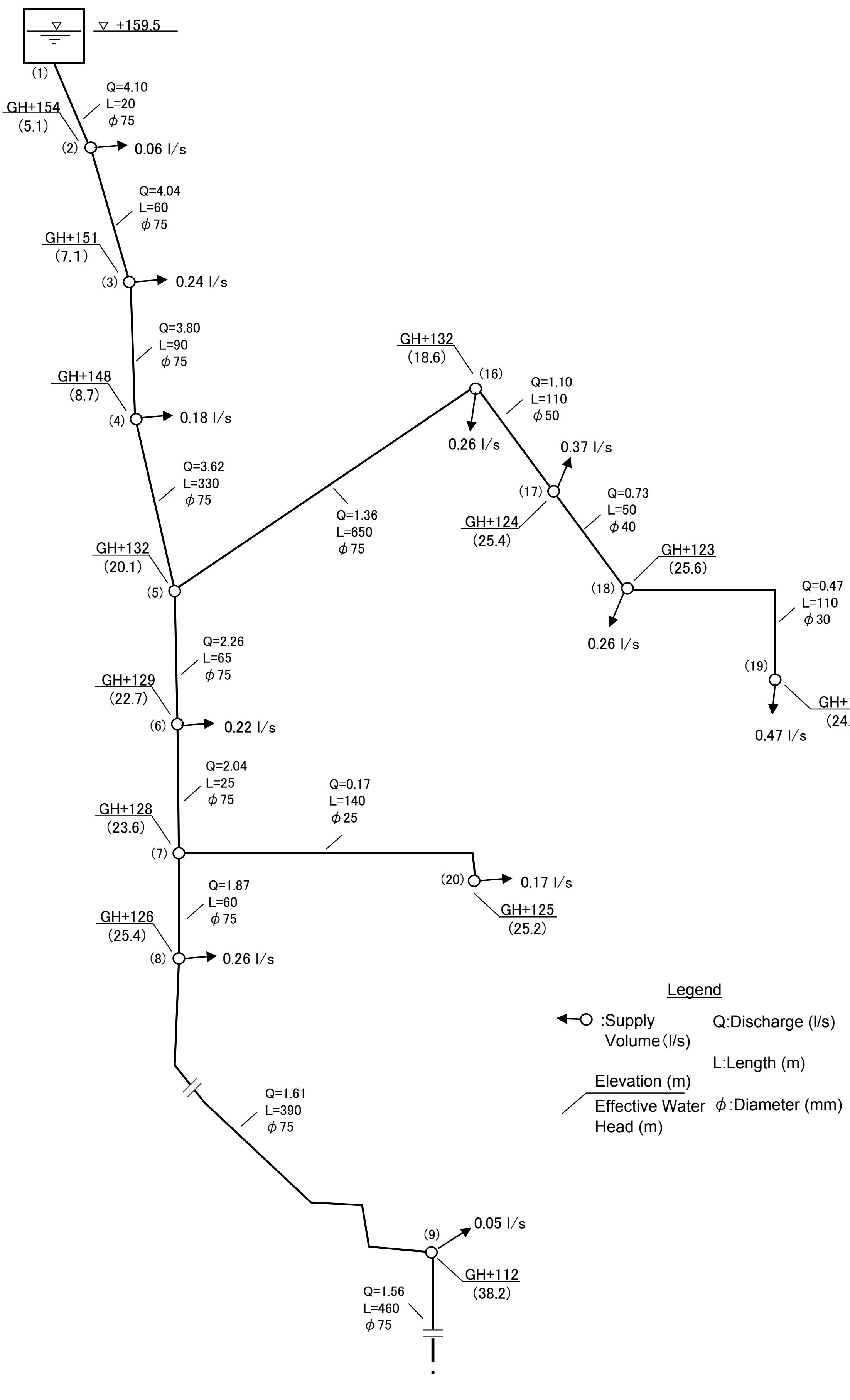
Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h (m)	H (m)	h(m)	he (m)	Note
Bug-Bug Reservoir Pressure Release Tank									77.0	74.0	3.0	H.W.L..
2 − 3	75	120	0.06	1.46	1800	0.330	2.6	4.7	72.3	60.0	12.3	
3 − 4	75	120	0.05	0.70	60	0.158	0.7	0.0	72.3	60.0	12.3	
4 − 5	50	120	0.00	0.48	170	0.244	2.4	0.4	71.9	59.0	12.9	
5 − 6	50	120	0.05	0.45	100	0.229	2.1	0.2	71.7	59.0	12.7	
6 − 7	40	120	0.05	0.27	50	0.215	2.4	0.1	71.6	58.5	13.1	
7 − 8	30	120	0.08	0.22	40	0.311	6.8	0.3	71.3	58.0	13.3	
8 − 9	25	120	0.08	0.11	90	0.224	4.6	0.4	70.9	57.0	13.9	
9 − 10	25	120	0.03	0.03	40	0.061	0.4	0.0	70.9	57.0	13.9	
3 − 11	50	120	0.06	0.65	50	0.331	4.2	0.2	72.1	59.0	13.1	
11 − 12	40	120	0.14	0.54	80	0.430	8.8	0.7	71.4	57.0	14.4	
12 − 13	30	120	0.29	0.29	90	0.410	11.3	1.0	70.4	57.0	13.4	
3 − 16	25	120	0.05	0.05	100	0.102	1.1	0.1	72.2	61.0	11.2	
4 − 17	30	120	0.07	0.17	80	0.241	4.2	0.3	72.0	54.0	18.0	
17 − 18	25	120	0.10	0.10	90	0.204	3.8	0.3	71.7	54.0	17.7	
5 − 19	25	120	0.03	0.03	220	0.061	0.4	0.1	71.8	61.0	10.8	
6 − 20	25	120	0.03	0.03	40	0.061	0.4	0.0	71.7	58.5	13.2	
6 − 21	25	120	0.07	0.10	250	0.204	3.8	1.0	70.7	59.0	11.7	
21 − 22	25	120	0.03	0.03	50	0.061	0.4	0.0	70.7	58.0	12.7	
8 − 23	25	120	0.03	0.03	40	0.061	0.4	0.0	71.3	58.0	13.3	
11 − 14	25	120	0.05	0.05	80	0.102	1.1	0.1	72.0	57.0	15.0	
12 − 15	25	120	0.11	0.11	70	0.224	4.6	0.3	71.1	57.0	14.1	

Remarks:

d :	Pipe diameter	I :	Hydraulic gradient
C :	Flow velocity coefficient	⊿h :	Loss head
q :	Discharge	H :	Dynamic water level
Q :	Flow rate	h :	Ground elevation
L :	Length of pipeline	he :	Effective head
V :	Velocity		

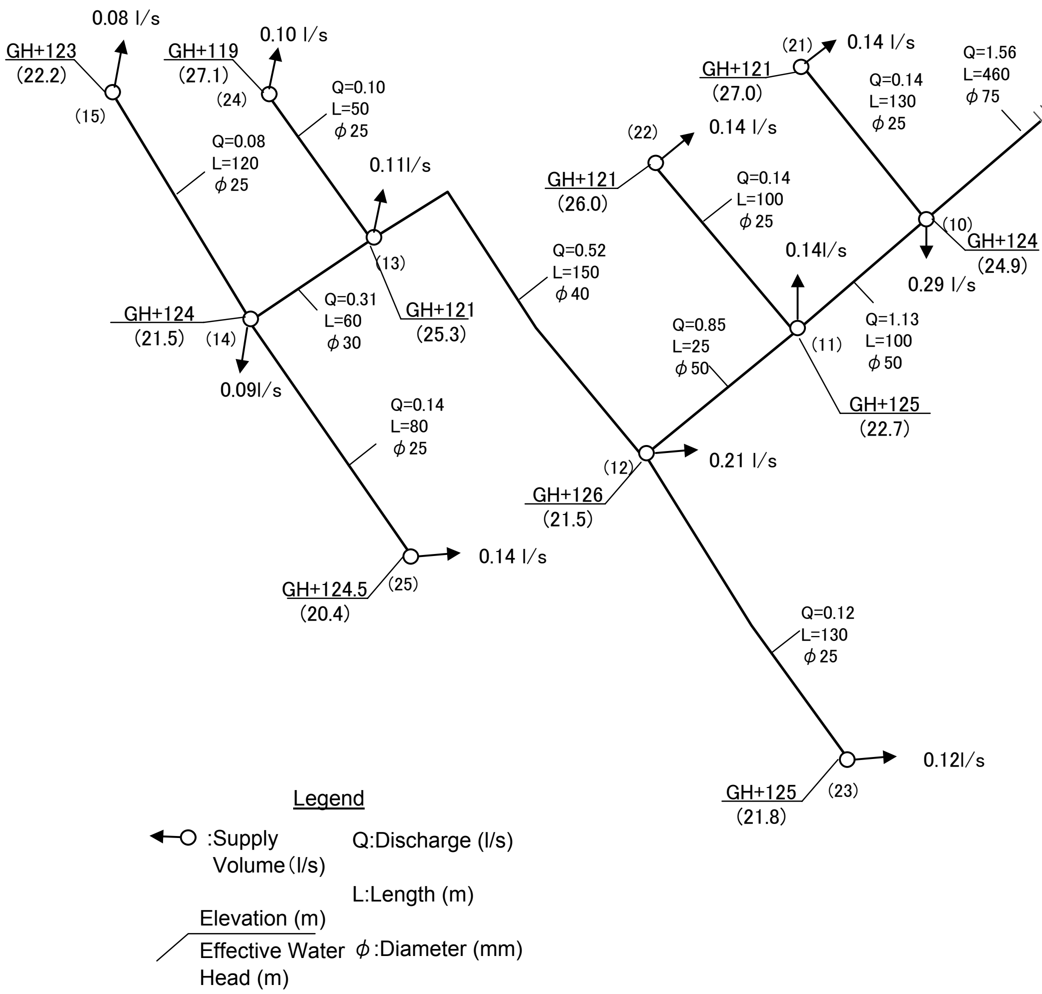
BAGIKPAPAN (1/2)

(Hourly Maximum)



BAGIKPAPAN (2/2)

(Hourly Maximum)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 6 Bagikpapan
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen-Williams' formula

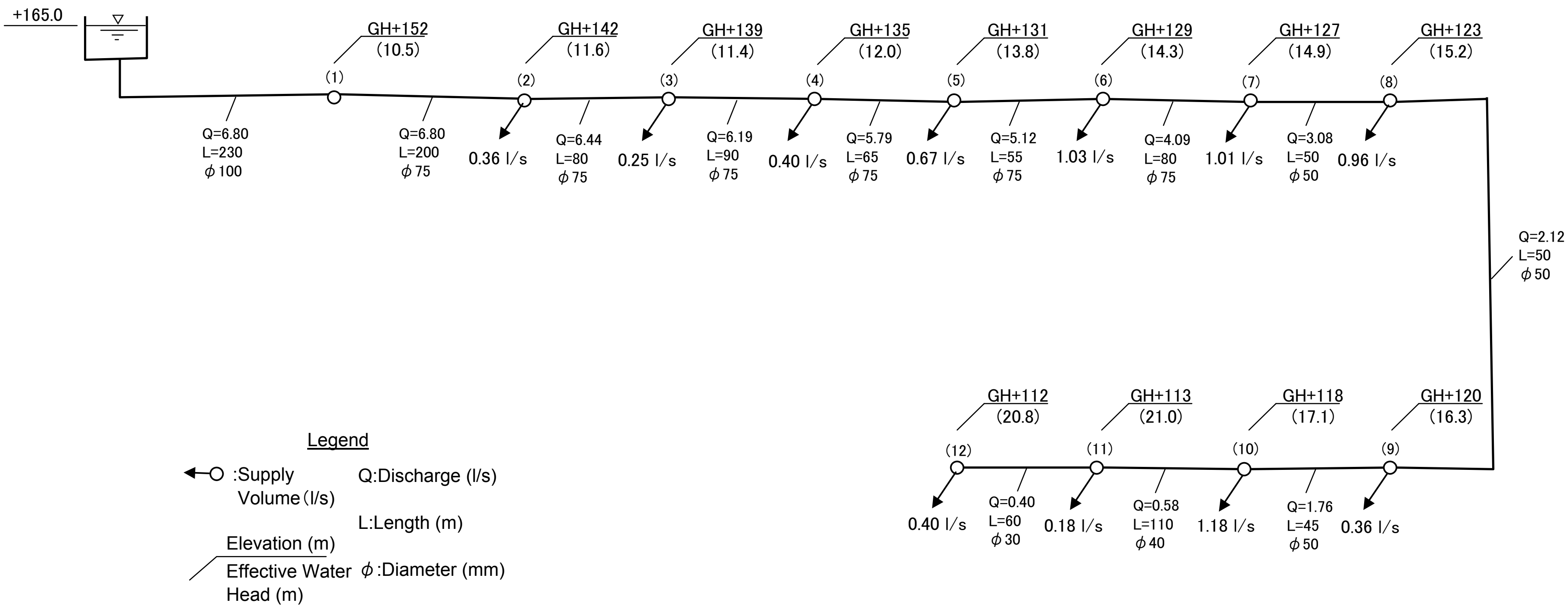
Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h(m)	H (m)	h(m)	he (m)	Note
Reservoir									159.5			L..W.L..
1 − 2	75	120	0.06	4.10	20	0.928	17.5	0.4	159.1	154.0	5.1	5.5
2 − 3	75	120	0.24	4.04	60	0.914	17.1	1.0	158.1	151.0	7.1	8.5
3 − 4	75	120	0.18	3.80	90	0.860	15.2	1.4	156.7	148.0	8.7	11.5
4 − 5	75	120	0.00	3.62	330	0.819	13.9	4.6	152.1	132.0	20.1	27.5
5 − 6	75	120	0.22	2.26	65	0.512	5.8	0.4	151.7	129.0	22.7	30.5
6 − 7	75	120	0.00	2.04	25	0.462	4.8	0.1	151.6	128.0	23.6	31.5
7 − 8	75	120	0.26	1.87	60	0.423	4.1	0.2	151.4	126.0	25.4	33.5
8 − 9	75	120	0.05	1.61	390	0.364	3.1	1.2	150.2	112.0	38.2	47.5
9 − 10	75	120	0.29	1.56	460	0.353	2.9	1.3	148.9	124.0	24.9	35.5
10 − 11	50	120	0.14	1.13	100	0.576	11.6	1.2	147.7	125.0	22.7	34.5
11 − 12	50	120	0.21	0.85	25	0.433	6.9	0.2	147.5	126.0	21.5	33.5
12 − 13	40	120	0.11	0.52	150	0.414	8.2	1.2	146.3	121.0	25.3	38.5
13 − 14	30	120	0.09	0.31	60	0.439	12.8	0.8	145.5	124.0	21.5	35.5
14 − 15	25	120	0.08	0.08	120	0.163	2.5	0.3	145.2	123.0	22.2	36.5
5 − 16	75	120	0.26	1.36	650	0.308	2.3	1.5	150.6	132.0	18.6	27.5
16 − 17	50	120	0.37	1.10	110	0.560	11.1	1.2	149.4	124.0	25.4	35.5
17 − 18	40	120	0.26	0.73	50	0.581	15.4	0.8	148.6	123.0	25.6	36.5
18 19	30	120	0.47	0.47	110	0.665	27.6	3.0	145.6	121.0	24.6	38.5
7 − 20	25	120	0.17	0.17	140	0.346	10.2	1.4	150.2	125.0	25.2	34.5
10 − 21	25	120	0.14	0.14	250	0.285	7.1	1.8	147.1	121.0	26.1	38.5
11 − 22	25	120	0.14	0.14	100	0.285	7.1	0.7	147.0	121.0	26.0	38.5
12 − 23	25	120	0.12	0.12	130	0.244	5.4	0.7	146.8	125.0	21.8	34.5
13 24	25	120	0.10	0.10	50	0.204	3.8	0.2	146.1	119.0	27.1	40.5
14 − 25	25	120	0.14	0.14	80	0.285	7.1	0.6	144.9	124.5	20.4	35

Remarks:

- d : Pipe diameter
- C : Flow velocity coefficient
- q : Discharge
- Q : Flow rate
- L : Length of pipeline
- V : Velocity
- I : Hydraulic gradient
- ⊿h : Loss head
- H : Dynamic water level
- h : Ground elevation
- he : Effective head

SELAPARANG

(Hourly Maximum)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTB 7 Slaparang
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen-Williams' formula

Node No.			d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h (m)	H (m)	h(m)	he (m)	Note
Reservoir L.W.L											165.0			Static head (m)
0		1	100	120	0.00	6.80	230	0.866	11.0	2.5	162.5	152.0	10.5	13.0
1	−	2	75	120	0.36	6.80	200	1.539	44.7	8.9	153.6	142.0	11.6	23.0
2	−	3	75	120	0.25	6.44	80	1.458	40.4	3.2	150.4	139.0	11.4	26.0
3	−	4	75	120	0.40	6.19	90	1.401	37.5	3.4	147.0	135.0	12.0	30.0
4	−	5	75	120	0.67	5.79	65	1.311	33.2	2.2	144.8	131.0	13.8	34.0
5	−	6	75	120	1.03	5.12	55	1.159	26.4	1.5	143.3	129.0	14.3	36.0
6	−	7	75	120	1.01	4.09	80	0.926	17.4	1.4	141.9	127.0	14.9	38.0
7	−	8	50	120	0.96	3.08	50	1.569	74.4	3.7	138.2	123.0	15.2	42.0
8	−	9	50	120	0.36	2.12	50	1.080	37.3	1.9	136.3	120.0	16.3	45.0
9	−	10	50	120	1.18	1.76	45	0.896	26.4	1.2	135.1	118.0	17.1	47.0
10		11	40	120	0.18	0.58	110	0.462	10.0	1.1	134.0	113.0	21.0	52.0
11	−	12	30	120	0.40	0.40	60	0.566	20.5	1.2	132.8	112.0	20.8	53.0

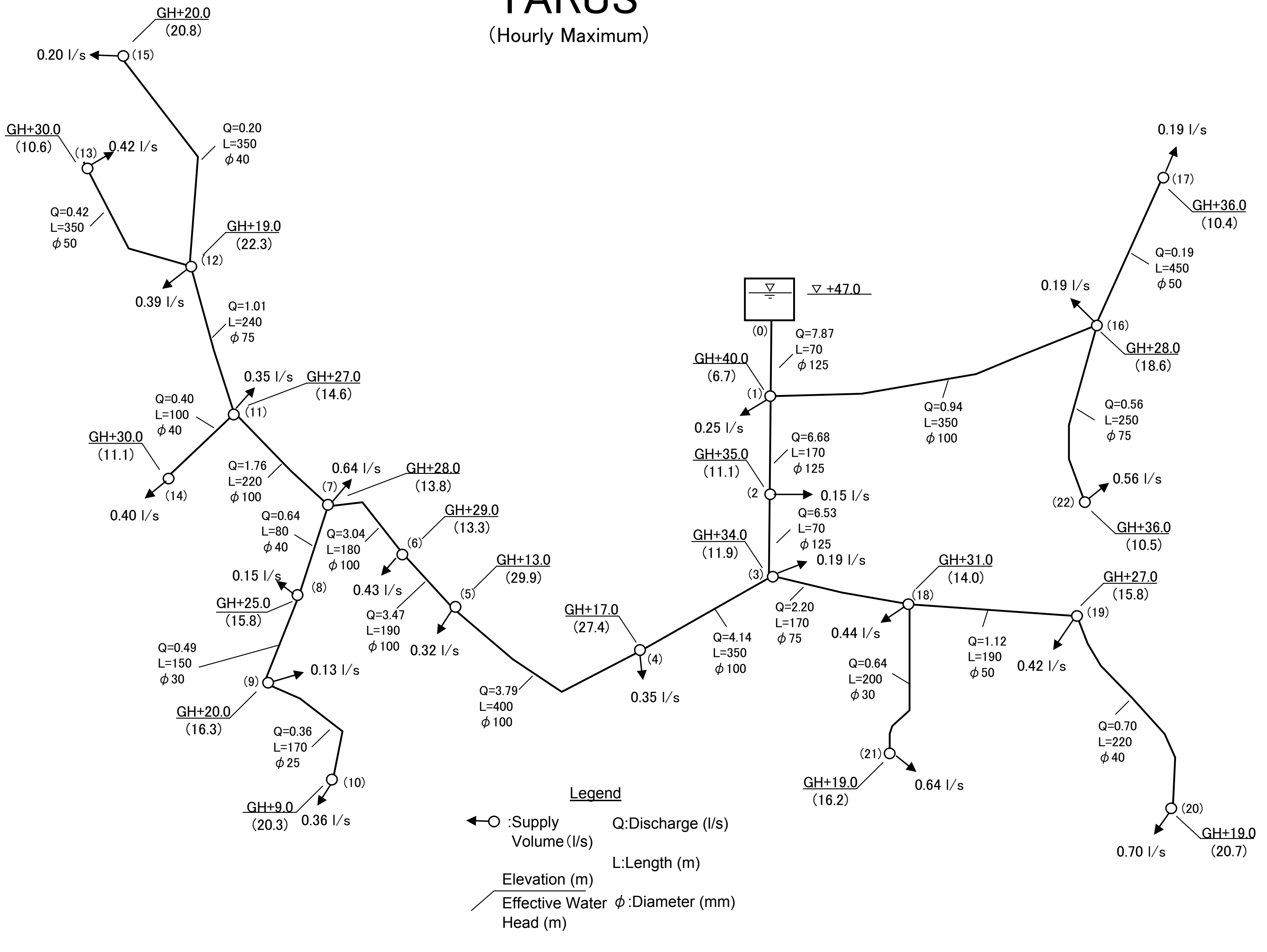
Remarks:

d : Pipe diameter
C : Flow velocity coefficient
q : Discharge
Q : Flow rate
L : Length of pipeline
V : Velocity

I : Hydraulic gradient
⊿h : Loss head
H : Dynamic water level
h : Ground elevation
he : Effective head

TARUS

(Hourly Maximum)



Project: RURAL WATER SUPPLY IN NUSA TENGGARA BARAT AND NUSA TENGGARA TIMUR
Site: NTT 9 Tarus
Route: Distribution Pipeline
Case: Hourly Maximum

HYDRAULIC CALCULATION

Hazen-Williams' formula

Node No.	d (mm)	C	q (L/s)	Q (L/s)	L (m)	V (m/s)	I(‰)	⊿h (m)	H (m)	h(m)	he (m)	Note
Reservoir water level									47.0			Low Water Level
0 - 1	125	120	0.25	7.87	70	0.641	4.9	0.3	46.7	40.0	6.7	
1 - 2	125	120	0.15	6.68	170	0.544	3.6	0.6	46.1	35.0	11.1	
2 - 3	125	120	0.19	6.53	70	0.532	3.4	0.2	45.9	34.0	11.9	
3 - 4	100	120	0.35	4.14	350	0.527	4.4	1.5	44.4	17.0	27.4	
4 - 5	100	120	0.32	3.79	400	0.483	3.7	1.5	42.9	13.0	29.9	
5 - 6	100	120	0.43	3.47	190	0.442	3.2	0.6	42.3	29.0	13.3	
6 - 7	100	120	0.64	3.04	180	0.387	2.5	0.5	41.8	28.0	13.8	
7 - 8	40	120	0.15	0.64	80	0.509	12.0	1.0	40.8	25.0	15.8	
8 - 9	30	120	0.13	0.49	150	0.693	29.8	4.5	36.3	20.0	16.3	
9 - 10	25	120	0.36	0.36	170	0.733	41.0	7.0	29.3	9.0	20.3	
7 - 11	100	120	0.35	1.76	220	0.224	0.9	0.2	41.6	27.0	14.6	
11 - 12	75	120	0.39	1.01	240	0.229	1.3	0.3	41.3	19.0	22.3	
12 - 13	50	120	0.42	0.42	350	0.214	1.9	0.7	40.6	30.0	10.6	
11 - 14	40	120	0.40	0.40	100	0.318	5.1	0.5	41.1	30.0	11.1	
12 - 15	40	120	0.20	0.20	350	0.159	1.4	0.5	40.8	20.0	20.8	
1 - 16	100	120	0.19	0.94	350	0.120	0.3	0.1	46.6	28.0	18.6	
16 - 17	50	120	0.19	0.19	450	0.097	0.4	0.2	46.4	36.0	10.4	
16 - 22	75	120	0.56	0.56	250	0.127	0.4	0.1	46.5	36.0	10.5	
3 - 18	75	120	0.44	2.20	170	0.498	5.5	0.9	45.0	31.0	14.0	
18 - 19	50	120	0.42	1.12	190	0.570	11.4	2.2	42.8	27.0	15.8	
19 - 20	40	120	0.70	0.70	220	0.557	14.2	3.1	39.7	19.0	20.7	
18 - 21	30	120	0.64	0.64	200	0.905	48.9	9.8	35.2	19.0	16.2	

Remarks:

d :	Pipe diameter	I :	Hydraulic gradient
C :	Flow velocity coefficient	⊿h :	Loss head
q :	Discharge	H :	Dynamic water level
Q :	Flow rate	h :	Ground elevation
L :	Length of pipeline	he :	Effective head
V :	Velocity		