CAPACITY ANALYSIS OF RESERVOIR BUILDING AND CLEAN WATER DISTRIBUTION IN LEMBANG BUA' TARRUNG, REMBON DISTRICT TANA TORAJA DISTRICT

Oleh
Reni Oktaviani Tarru[1], Harni Eirene Tarru[2], Yephta Biu' Padatuan[3]
[1,2,3]Toraja Indonesian Christian University
Email: [1]renioktaviani@gmail.com

Abstract

Lembang Bua' Tarrung is one of the Lembang in the District Rembon Tana Toraja Regency and has 4 hamlets , namely Merrara Hamlet , Buttu Hamlet , Karappa ' Lebusan Hamlet, and Lebani ' Tiroallo Hamlet . Lembang Bua' Tarrung is area hills and have cool climate . _ In the area this , number growth population Keep going increase every year so that the need for clean water will also Keep going increase . In Buttu Hamlet there is a reservoir building serving community water needs with a volume of 12.5 m3 and distributed with 50 mm (2 in) diameter PVC pipe , will but the available water in this reservoir not yet distributed by equally to all society , so study this aim for knowing capacity adequate reservoir and pipe size as channel distribution of clean water in Lembang Bua' Tarrung. Method in study this is method quantitative with count maximum water requirement in order to determine capacity reservoir building and water demand at peak hours for determine pipe size as channel clean water distribution. Research results show that capacity reservoir building 25% of maximum water requirement , which is 32.4 m3 with dimensions of 3.6 m × 3 m × 3 m. Distribution pipe with a diameter of 3 inches HDPE type . 8 hydrants general dotted service with each with a capacity of 23.1 m3.

***Keywords: Clean Water , Bua' Tarrung , Distribution , Capacity*.**

PENDAHULUAN

Clean water is one needs tree human needed by sustainable. The use of clean water is very important for consumption house stairs , need industry and place general (Hosseiny et al., 2021). Because of the importance needs of clean water , then reasonable thing if clean water sector get priority handling main because concerning people 's lives. Fulfillment The need for clean water is very dependent on the availability sources of clean water which include: could obtained from ground water and surface water that is could provided from rivers, springs, weirs and reservoirs / dams (Quitana et al., 2020).

Remembering clean water is needs that are not limited and sustainable which must fulfilled every moment, no only regarding sufficient debit but by quality fulfill applicable standards and quantity nor continuity must could Fulfill needs the community it serves (Koehler et al., 2018).

Lembang Bua' Tarrung is one from 11 Lembang and 2 Kelurahan in the District Known Rembon as a Climate Village in Tana Toraja Regency and has a growth resident who continues increase each year . In terms of this needs will clean water too the more increase for fulfill needs society, ok needs domestic and non domestic (Achore et al., 2020). For fulfill needs that, distribution of clean water to society must also divided by evenly. But what happened in Lembang Bua' Tarrung , the clean water available in the tub reservoir (reservoir) yet distributed equally to society, so still many communities that use water from source another. Because that need existence analysis reservoir building and distribution on the existing clean water supply moment this is for distribution could equally to society (Wang et al., 2022).

1.1 *Estimation Amount Population*

Projection clean water needs could determined with notice growth population for projected to clean water needs until with fifty year coming or depends from desired projection (Ağbulut, 2022).

As for related with projection needs the is number Growth Residents. Growth rate population calculated with percentage use the formula :

$$(\%) = \frac{\text{Penduduk}_n - \text{Penduduk}_0}{\text{Penduduk}_0} \times 100 \text{ .... } 2.1$$

There are several method used for project amount population among others, namely :

1) Arithmetic Method

The formula used in the method projection arithmetic are :

$P_t = P_0 (1+ rt)$ 2.2

where :

Pt = amount population in year t
P_0 = amount population in _ base
r = speed growth population
t = period time Among year base and year t (in year)

2) Geometric Method

The following formula is used in the method geometric :

$P_t = P_0 (1+ r)^t$ 2.3

where :

P_t = sum population in year t
P0 _ = sum population in the year base
r = speed growth population
t = period time Among year base and year t (in year)

3) Exponential Method

The formula used in the method exponential are :

$P_t = P_0 e^{rt}$ 2.4

where :

Pt = amount population in year t
P_0 = sum population in _ base
r = speed growth population
t = period time Among year base and year t (in year)
e = number tree from system natural logarithm (ln) whose magnitude is 2.7182818

1.2 *Estimation Clean Water Needs*

1) *Domestic Water Demand (Qd)*

Domestic water is the water used for necessity house ladder such as drinking water, cooking, washing and so on (Smiley & Stoler, 2020). Needs domestic determined by the presence consumer domestic, originating from population data, pattern habits, and levels supported life existence development social economy that delivers trend enhancement clean water needs. Water requirement per person per day customized with usual standard used as well as criteria service by category the city. In it every category certain water requirement per person per day vary (Yee et al., 2021).

For knowing criteria the need for clean water for each category could seen in the table following this .

Table 1. Clean Water Needs

DESCRIPTION	CATEGORY OF CITY BY NUMBER OF POPULATION (SOUL)				
	>1,000,000	500,000 up to 1,000,000	100,000 s/d 500,000	20,000 s/d 100,000	<20,000
	City Metropolitan	City Big	City Currently	City Small	Village
1	2	3	4	5	6
1. Consumption of House Connection Units (SR) (liters/person/ day)	> 150	150 - 120	90 -120	80 - 120	60 -80
2. Consumption of Hydrant Units (HU) (liters/person/ day)	20 – 40	20 - 40	20 - 40	20 - 40	20 - 40
3. Consumption of Non-Domestic Units a. Small Business (liters/person/ day) b. Big Commerce (liters/person/ day) c. Large Industry (liters/person/ day) d. Tourism (liters/person/ day)	600 - 900 1000 - 5000 0.2 - 0.8 0.1 - 0.3	600 - 900 1000 - 5000 0.2 - 0.8 0.1 - 0.3		600 1500 0.2 - 0.8 0.1 - 0.3	
4. Water Loss (%)	20 - 30	20 - 30	20 - 30	20 - 30	20 - 30
5. Maximum Day Factor	1.15 – 1.25 * daily	1.15 – 1.25 * daily	1.15 – 1.25 * daily	1.15 – 1.25 * daily	1.15 – 1.25 * daily
6. Peak Hour Factor	1.75 – 2.0 * days max	1.75 – 2.0 * days max	1.75 – 2.0 * days max	1.75 * days max	1.75 * day max
7. Number of Souls Per SR (Soul)	5	5	5	5	5
8. Number of Souls Per HU (Soul)	100	100	100	100 - 200	200

DESCRIPTION	CATEGORY OF CITY BY NUMBER OF POPULATION (SOUL)				
	>1,000,000	500,000 up to 1,000,000	100,000 s/d 500,000	20,000 s/d 100,000	<20,000
	City Metropolitan	City Big	City Currently	City Small	Village
1	2	3	4	5	6
9. Remaining Press in Provision Distribution (Meters)	10	10	10	10	10
10. Operating Hours (Hours)	24	24	24	24	24
11. Volume Reservoir (% Max Day Demand)	15 - 25	15 - 25	15 - 25	15 - 25	15 - 25
12. SR : HU	50 : 50 s/d 80 : 20	50 : 50 s/d 80 : 20	80 : 20	70 : 30	70 : 30
13. Cakupan Pelayanan (%)	90	90	90	90	70

Source : Criteria Planning Directorate General of Public Works Creation, 1996

2) Non Domestic Water Needs (Qnd)

Non domestic water is the water used for necessity industry, tourism, places of worship, places social as well as the place commercial and general other (Ziyaee, 2018).

Table 2. Non- Domestic Water Demand For Category I, II, III, IV

SECTOR	SCORE	UNIT
School	10	liter/student/ day
Hospital	200	liter/bed/ day
Public health center	2000	liter/unit/ day
Mosque	3000	liter/unit/ day
Office	10	liters/ employee / day
Market	12000	liter/ ha / day
Hotel	150	liter/bed/ day
Restaurant	100	liters/ seat / day
Complex Military	60	liter/person/ day
Industrial Area	0.2 - 0.8	liter/ second / hectare
Tourism Area	0.1 - 0.3	liter/ second / hectare

Source : Criteria Planning Directorate General of Human Settlements, Department of Public Works, 1996

Table 3. Non - Domestic Water Demand For Category V (Village)

SECTOR	SCORE	UNIT
School	5	liter/student/ day
Hospital	200	liter/bed/ day
Public health center	1200	liter/unit/ day
Mosque	3000	liter/unit/ day
prayer room	2000	liters/ employee / day
Worship	5	liter/person/day
Market	12000	liter/ ha / day
Commercial / Industrial	10	liter/ day

Source : [1] Criteria Planning Directorate General of Human Settlements, Department of Public Works, 1996

[2] SNI 03-7065-2005 Procedures for Planning Plumbing Systems.

a. Reservoir Building

1) Reservoir Function

Function main from the reservoir is for balancing between production discharge and water use discharge (de Wit et al., 2022). Often for at the same time, clean water production discharge no could always same big with water usage discharge. At the moment amount clean water production more big than amount water usage, then the excess water for temporary saved in the reservoir, and used return for fulfill lack of water at the time amount clean water production more small than amount water use (Domingo & Nadal, 2019).

2) Distribution Reservoir Capacity

For knowing volume capacity required reservoir dimensions i.e. 20% of maximum water requirement . For calculate reservoir volume can use formula :

V=PLD ……………………………………………. 2.5

Where :

V = Volume (m3)
L = Width (m)
P = Length (m)
D = Depth (m)

b. Network System Distribution

Generally available on the system network clean water distribution are :

1) Primary pipe or main pipe
2) Secondary Pipe
3) Tertiary pipe
4) Service Pipe

c. Piping

1) Pipe Type
   a) Plastic Pipe (PVC)
   b) iron pipe pour
   c) Concrete pipe
   d) steel pipe
   e) HDPE (High Density Polyethylene) Pipe
   f) White pipe (GIP)
2) Determination of pipe diameter

In determining pipe dimensions used for activity water transmission and distribution can be calculated use formula :

$$Q = V \times A \quad \text{.................. 2.6}$$

$$V = \frac{Q}{\frac{1}{4}\pi \times D^2} \quad \text{.................................. 2.7}$$

$$D = \sqrt{\frac{Q \times 4}{\pi \times V}} \quad \text{.. 2.8}$$

Where:

Q = Discharge (m^3/ sec)
V = Speed flow (0.9 - 2) (m/ sec)
A = Cross -sectional area (m^2)
D = Diameter of pipe (m)

Rated speed Genre in allowable pipe is of 0.3 – 2.5 m/ s at peak hourly discharge . Then speed Genre is known with use method *trial and error.*

3) Lost energy in the pipe
   a. Lost energy consequence friction in the pipe

Lost energy consequence friction in the pipe can determined with Darcy Weisbach equation as following :

$$Hf = f\frac{L}{D}.\frac{V^2}{2g} \quad \text{... 2.9}$$

Where:

Hf = Loss of energy due to friction (m)
f = Coefficient swipe
L = Pipe length (m)
D = Diameter of pipe (m)
V = Speed flow (m/ sec)
g = Acceleration gravity (9.8 m/ s)

Based on equation 2.9 f is calculated with equality Swamee and Jain (1976) as following .

$$f = \frac{0{,}25}{\left[\log\left(\frac{k}{3{,}7D} + \frac{5{,}74}{Re^{0{,}9}}\right)\right]^2} \quad \text{.................2.10}$$

Equation above _ apply for range $5.10^{3} < Re < 10^{6}$ and $10^{-6} < k/D < 10^{-2}$

For Re is calculated with equality following this .

$$Re = \frac{V.D}{\nu} \quad \text{.. 2.11}$$

Where:

k = Roughness of pipe
D = Diameter of pipe (m)
Re = Reynolds number
V = Speed flow (m/ sec)
= *Viscosity* _ kinematic (m^2/ sec)

Table 4. Hardness Values Wall For Various Commercial Pipes

Ingredient	Roughness (mm)
brass	0.0015
Concrete	
- Steel forms, smooth	0.18
- Good joints, average	0.36
- Rough, visible form mark	0.60
Copper	0.0015
Corrugated metal (CMP)	45
Iron	
- Asphalted lined	0.12
- Cast	0.26
- Ductile; DIP-Cement mortar	0.12
lined	0.15
- Galvanized	0.045
- Wrought	
Polyvinyl chloride (PVC)	0.0015
Polyethylene,high density (HDPE)	0.0015
Steel	
- Enamel coated	0.0048
- Riveted	0.9 – 9.0
- Seamless	0.004
- Commercial	0.045

Source : Robert J. Houghtalen , Ned HC Hwang, A. Osman Akan. "Fundamentals of Hydraulic Engineering Systems Fourth Edition ". Pearson. New Jersey. 2010

Table 5. Viscosity Kinematics

Temperature ^{0} C	Viscosity Kinematics (m^2 / sec)
0	1,787 x 10 $^{-6}$
1	1,728 x 10 $^{-6}$
2	1.671 x 10 $^{-6}$
3	1,618 x 10^{-6}
4	1,567 x 10^{-6}
5	1,519 x 10^{-6}
6	1,472 x 10^{-6}
8	1,386 x 10^{-6}
10	1,307 x 10^{-6}
12	1,235 x 10^{-6}
14	1,169 x 10^{-6}
16	1,109 x 10^{-6}
18	1,052 x 10^{-6}
20	1,002 x 10^{-6}
25	0,890 x 10^{-6}
30	0,798 x 10^{-6}
35	0,719 x 10^{-6}
40	0,653 x 10^{-6}
45	0,596 x 10^{-6}
50	0,547 x 10^{-6}
60	0,467 x 10^{-6}
70	0,404 x 10^{-6}
80	0,355 x 10^{-6}
90	0,315 x 10^{-6}
100	0,282 x 10^{-6}

b. Lost energy consequence Bend or change cross section

Lost energy consequence bends and changes pipe cross section is stated in form general :

$$Hf = K\frac{V^2}{2g} \quad \ldots\ldots 2.12$$

Where:

Hf = Lost energy (m)

K = Coefficient lost power on bends (0 - 1)

V = Speed flow (m/ sec)

g = Acceleration gravity (9.8 m/ s)

RESEARCH METHOD

2.1 Overview of Research Sites

Research location is in Lembang Bua' Tarrung Subdistrict Rembon Tana Toraja Regency has 4 hamlets, namely : Merrara Hamlet, Buttu Hamlet, Karappa ' Lebusan Hamlet, and Lebani ' Tiroallo Hamlet. By geographical reservoir building is located between 3 ^{0} 06' 63" Latitude south, 119 ^{0} 45'58" Longitude east with elevation 1,379 Meters above surface sea (masl).

Figure1. Research Location

2.2 Flowchart Research

1. Finding

a. Projection Amount Population

Projection about amount population is is step beginning in count clean water needs in the future. On discussion this planned projections for the next 10 years come counted start from 2020 to 2029. For knowing amount residents in Lembang Bua'.

Tarrung at 10 years old future, then need conducted projection population with quantity data resident 5 years final from 2015 to 2019. For know average growth residents, especially formerly calculated rate growth resident.

Table 6. Average Rate Growth Growth Population

Year	Amount Population (soul)	.	
		Soul	Message (%)
2015	827	-	-
2016	834	7	0.846
2017	840	6	0.719
2018	935	95	11.310
2019	961	26	2,781
Amount		134	15,656
r%		3,914	
Average growth		33.50	

Source : Calculation results

1. Determine Method Projection Growth Population

On determination method projection this used 3 methods, namely : method arithmetic, geometric, and exponential (Leoneti & Gomes, 2021). Criteria election method this using correlation test.

a) Arithmetic Method

$P_t = P_0 (1 + rt)$

Example calculation :

2016 = 827 (1 + 3.914% x 1)
= 859 souls

Table 7 Calculations With Method Arithmetic

Year	t	Amount Resident (Soul)
2015	0	827
2016	1	859
2017	2	892
2018	3	924
2019	4	956

Source : Calculation results

a) Geometric Method

$P_t = P_0 (1 + r)^t$

Example calculation :

2016 = 827 (1 + 3.914%) ^{1}
= 859 souls

Table 8 Calculations With Method Arithmetic

Year	t	Amount Resident (Soul)
2015	0	827
2016	1	859
2017	2	893
2018	3	928
2019	4	964

Source : Calculation results

a) Exponential Method

$P_t = P_0 e^{rt}$

Example calculation :

2016 = 827 x 2.7182818 3.914 % x 1

= 860 souls

Table 9 Calculations With Method Exponential

Year	t	Amount Resident (Soul)
2015	0	827
2016	1	860
2017	2	894
2018	3	930
2019	4	967

Source : Calculation results

b) Correlation Test

For get score coefficient correlation could calculated with help *Microsoft excel* (used *Ms. excel* 2010), where score coefficient correlation (R) close to 1 or R = 1 is used.

Table 10. Calculation Of Correlation Test

Year	t	Amount population (soul)	Calculation Results		
			Arithmetic	Geometric	Exponential
2015	0	827	827	827	827
2016	1	834	859	859	860
2017	2	840	892	893	894
2018	3	935	924	928	930
2019	4	961	956	964	967
Coefficient correlation			0.919367992	0.925151588	0.925258219

Source : Calculation results

Based on Table 4.5 the value of results more correlation test calculations _ close to 1 i.e method exponential , then for project amount residents of Lembang Bua' Tarrung used method exponential. Count amount 10 year old resident upcoming.

Year	P 0	t	r	e	Amount Projection
2019	961	0	3.91	2.7182818	961
2020	961	1	3,91	2,7182818	999
2021	961	2	3,91	2,7182818	1039
2022	961	3	3,91	2,7182818	1081
2023	961	4	3,91	2,7182818	1124
2024	961	5	3,91	2,7182818	1169
2025	961	6	3.91	2.7182818	1215
2026	961	7	3.91	2.7182818	1264
2027	961	8	3.91	2.7182818	1314
2028	961	9	3.91	2.7182818	1367
2029	961	10	3.91	2.7182818	1421

Source : Calculation results

Based on results calculation on could is known amount residents who will use clean water . In accordance with analysis 10 year projection will come so taken amount population 2029 with total 1,421 people , from amount the in accordance Table 2.1 Lembang Bua' Tarrung enter category V (village) with amount population <20,000.

a. Water Demand Analysis

1) Calculation domestic water demand (Qd)

Known :

a. Amount population year 2029 = 1,421 souls
b. Use of SR = 80Ltr/org/ hr
c. Scope service = 70%
d. Service target = 100%

Qd = Population served xbxd
Population served = axc
= 1,421 x 70%
= 995
Qd = 995 x 80 x 100%
= 79,600 Liters/person/ day
= 0.921 liter/ second

2) Calculation non- domestic water needs (Qnd)

3) Requirement (Qt)
Qt = Qd + Qnd
= 0.921 + 0.039
= 0.960 liters/ second

4) Loss of water (Qhl)
Qhl = Qt × 20%
= 0.960 × 20%
= 0.192 liter/ second

5) Average water requirement (Qr)
Qr = Qt + Qhl
= 0.960 + 0.192
= 1.152 liters/ second

6) Daily water needs maximum (Qmax)
Qmax = Qr × 1.25
= 1.152 × 1.25
= 1,440 liters/ second

7) Peak hour water demand (QJP)
Qjp = Qr × 1.75
= 1.152 × 1.75
= 2.017

Based on results calculation above, result projection clean water needs start 2020 to 2029 can seen in table 4.8.

ISSN No. 1978-3787
Open Journal Systems

Table 12. Projections Water Needs

No	Description	Unit	Year										
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
1	Service population												
	amount population	Soul	961	999	1.039	1.081	1,124	1.169	1,215	1,264	1.314	1.367	1.421
	scope service	%	70	70	70	70	70	70	70	70	70	70	70
	population served	Soul	673	700	727	757	787	818	851	885	920	957	995
2	domestic water needs												
	level service	%	100	100	100	100	100	100	100	100	100	100	100
	water usage	Ltr /org/ hr	80	80	80	80	80	80	80	80	80	80	80
	domestic water needs	ltr /sec	0.623	0.648	0.674	0.700	0.728	0.758	0.788	0.819	0.852	0.886	0.921
3	Non-domestic water needs	Ltr /sec	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
4	Total water requirement	Ltr /sec	0.662	0.687	0.713	0.739	0.767	0.797	0.827	0.858	0.891	0.925	0.960
5	Water loss	Ltr /sec	0.132	0.137	0.143	0.148	0.153	0.159	0.165	0.172	0.178	0.185	0.192
6	Average water requirement	Ltr /sec	0.794	0.824	0.855	0.887	0.921	0.956	0.992	1.030	1.069	1.110	1.152
7	Maximum water requirement	Ltr /sec	0.993	1.030	1.069	1.109	1.151	1,195	1,240	1,287	1.336	1.387	1,440
8	Peak hour water demand	Ltr /sec	1,390	1,442	1,496	1.553	1,612	1,673	1,736	1,802	1,871	1,942	2.017

Water Source Discharge Calculation

Calculation of water source discharge carried out in the field , that is use method lifebuoy with data as following :

Table 13. Discharge Measurement Data

Average time (seconds)	-sectional length (m)	Wide mean cross section (m)	Average depth of cross section (m)
29.2	6	3.8	0.283

Flow rate calculation calculated use equation 2.6 as following :

Q = AV

A = Width × Depth cross section

= 3.8 × 0.283

= 1.075 m2

$$V = \frac{\text{Jarak}}{\text{Waktu}}$$

$$= \frac{6}{29{,}2}$$

= 0.206 meters/ second

Q = 1.075 × 0.206

= 0.221 m3 / sec

= 221 liters/ second

Based on results the calculation above , the discharge at the water source in Lembang Bua' Tarrung could Fulfill needs Public until year 2029.

Reservoir Capacity Analysis

Capacity to be accommodated by the specified reservoir based on maximum water demand (Table 4.9), which is 125,908 lit/day.

Based on Table 2.1 the reservoir volume is 25% of maximum water requirement per day . Then the required reservoir capacity calculated as following :

Qmax = 1,440 liters/ second

= 124.416 liters/ day

Reservoir capacity = 124.416 ltr / hr × 25%

= 31.104 ltr / hr

= 31.104 m^3

After get the required reservoir capacity , then calculated reservoir capacity in the field with data as following :

P = 2.5 m

L = 2.5 m

T = 2 m

Volume = W × L × H

= 2.5 × 2.5 × 2

= 12,5 m^3 < 31,104 m^3 (TIDAK SESUAI)

Based on results calculation on obtained reservoir capacity in the field no in accordance with water requirement up to year 2029. As for the reservoir at this only capable serve water needs with calculation following this :

Qmax 2019 = 0.993 liter/ second

= 85,778 liters/ day

Capacity seservoir = 85,778 × 25%

= 21,445 liters/ day

= 21,445 m^3

$$\text{Terlayani (\%)} = \frac{12{,}5}{21{,}445} \times 100$$

= 58.29%

Based on calculation above the water available in the current reservoir this only capable serve Public of 58.29%, then from that need planned return in accordance with analysis until year 2029 with dimensions as following :

P = 3.6 m

L = 3 m

T = 3 m

Volume = W × L × H
= 3.6 × 3 × 3
= 32.4 m^3 > 31.104 m^3 (OK)

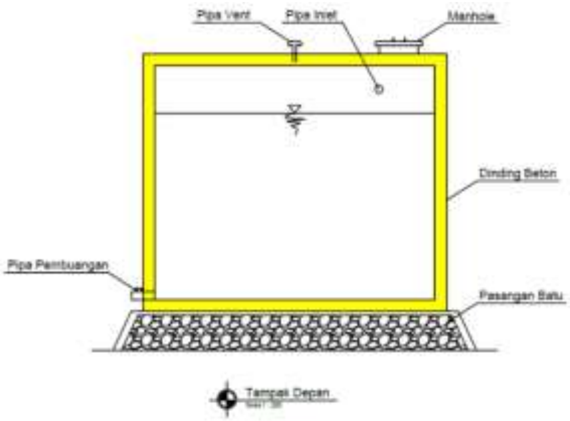

Figure 2. Looks Front Reservoir Building

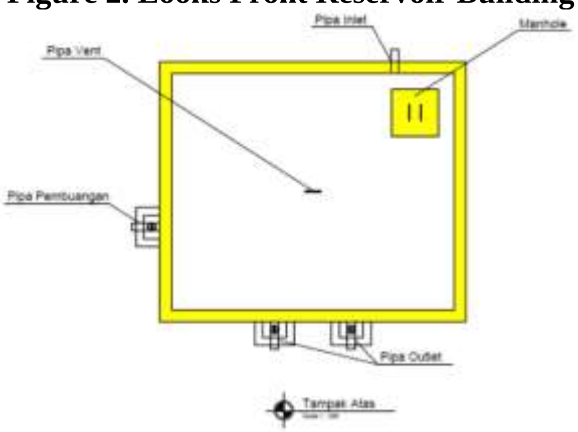

Figure 3. Looks On Reservoir Building

1. **Distribution System In The Field**

Clean water distribution system in Lembang Bua' Tarrung moment this, that is system flow by gravity from reservoir to tub release press (CPM), then in this CPM also used as water divider to Public by direct and forward to hydrant general (HU). Amount hydrant existing general moment this is 2 units with capacity accommodate 1.2 m^3 . Type of distribution pipe used is 50 mm diameter PVC.

As for the conditions distribution moment this not yet divided by equally to Public because the condition of the area is hilly and the number of hydrant less general with capacity that is not in accordance with amount service (Soteropoulos et al., 2020). Apart from that in some point many pipes are experiencing leakage consequence condition the path through which the pipe passes and also the influence great water pressure because BPT placement has different height more from 100 m. Pipe leaks due to water pressure is caused by poor pipe quality not enough support (Fan et al., 2022).

2. **Distribution System plan**

Distribution system this, that is drain water from the reservoir through tub release press (CPM) then forwarded to the hydrant general (HU) (Kupel, 2022). Distribution pipe through some CPM due to condition area services located in the area mountains so that have difference sufficient elevation far where the reservoir is at an altitude of 1,379 MDPL, while HU1 is at an altitude of 1,138 MDPL. Hydrant general planned so that water can divided by equally for Fulfill needs the community it serves (Turner, 2021). Amount service on hydrant general determined based on table 2.1, which is 200 people per HU with amount as following :

Amount population = 1421

$$\text{Jumlah HU} = \frac{1421}{200}$$

= 7.105 ~ 8 Units

After determine amount hydrant general , next calculated needs the water . Hydrant water requirement general determined based on peak hour water demand. Amount water needs in every hydrant general as following :

$$= \frac{2{,}017 \text{ ltr/det}}{8}$$

= 0.252 ltr /sec/HU
= 21,773 ltr / hr /HU
= 21,773 m ^{3}

Based on calculation on planned dimensions hydrant general as following :

P = 3.5 m
L = 3 m
T = 2.2 m

Volume = W × L × H
= 3.5 × 3 × 2.2
= 23.1 m ^{3} > 21.773 m ^{3} (OK)

Figure 4. Location Of Planned HU Placement

Table 14. Height Data Hydrant General

No	HU number	Elevation (MDPL)
1	HU1	1.138
2	HU2	1.104
3	HU3	1.098
4	HU4	963
5	HU5	915
6	HU6	1.009
7	HU7	910
8	HU8	885

a. Determining the Diameter of the Distribution Pipe

For determine the diameter of the distribution pipe to each hydrant general calculated based on peak hour debit use equation 2.8 as following :

$$D = \sqrt{\frac{Q \times 4}{\pi \times V}}$$

Q = 2,017 liters/ second
= 0.00204 m ^{3} / sec
V is assumed = 0.5 m/ sec
So:

$$D = \sqrt{\frac{0{,}002017 \times 4}{3.14 \times 0{,}5}}$$

= 0.0717 m
= 71.7 mm ~ 76.2 mm = 3 inches

On planning this HDPE pipe is used because pass the winding path that is bustling in the area hills. As for the advantages using HDPE pipes, namely the material is flexible and strong so it fits used in the area hills . In addition , HDPE pipes are also capable of endure up to 50 years .

b. Lost energy in the pipe

1) Lost energy consequence friction in the pipe

The size lost energy could determined with equation 2.9 as following .

$$Hf = f\,\frac{L}{D}.\frac{V^2}{2g}$$

Example calculation :

Is known water temperature of 20 ^{0}C

$$Re = \frac{V.D}{\nu}$$

$$Re = \frac{0{,}5 \text{ x } 0{,}0762}{1{,}002 \text{ x } 10^{-6}}$$

= 38,023

$$f = \frac{0{,}25}{\left[\log\left(\frac{k}{3{,}7D} + \frac{5{,}74}{Re^{0{,}9}}\right)\right]^2}$$

$$f = \frac{0{,}25}{\left[\log\left(\frac{0{,}0000015}{3{,}7 \text{ x } 0{,}0762} + \frac{5{,}74}{38.023^{0{,}9}}\right)\right]^2}$$

= 0.022

CPM1 - HU1

L= 460 m

D= 76.2 mm = 0.0762 m

$$Hf \quad = 0,022 \; \frac{460}{0,0762} \cdot \frac{0,5^2}{2 \; . \; 9,8}$$

= 1,360

Table 15. Loss Energy Consequence Friction In The Pipe

Pipe	L(m)	D(m)	V(m/s)	g	f	Hf(m)
CPM1 - HU1	460	0.0762	0,448	9,8	0.023	1,360
BPT1 - HU2	540	0.0762	0,448	9,8	0.023	1,596
BPT2 - HU3	560	0.0762	0,448	9,8	0.023	1,656
HU2 - HU6	325	0.0762	0,448	9,8	0.023	0.061
HU6 - HU7	535	0.0762	0,448	9,8	0.023	1,582
HU6 - HU8	590	0.0762	0.448	9.8	0.023	1,744
HU3 - HU4	570	0.0762	0.448	9.8	0.023	1,685
HU4 - HU5	305	0.0762	0.448	9.8	0.023	0.902
Total						11,486

Source : Calculation results.

2) Lost energy consequence turn or change cross section

Lost energy consequence turn or change pipe cross section is determined based on equation 2.18 as following :

0 < K 1, the calculated value of K by 1

$$Hf \quad = K \frac{V^2}{2g}$$

$$= 1 \frac{0,448^2}{2.9,8}$$

= 0.0102 m

Hf total = 8 × 0.0102

= 0.082 m

Based on calculation above the total loss energy that happens in pipe flow , i.e. total loss energy consequence friction plus total loss energy consequence turn or change cross section as following := 11.486 + 0.082 = 12,568 m.

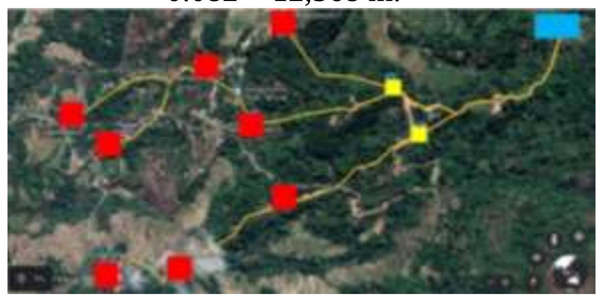

Figure 5. Plan system network clean water distribution

Information Image :

Reresvoir

Bak Pelepas Tekan

Hidran Umum

Pipa Distribusi

CONCLUSION

Based on results discussion in chapter previously could taken conclusion as following : Capacity adequate reservoir building for the need for clean water in Lembang Bua' Tarrung until in 2029, which is 25% of maximum water requirement with a volume of 32.4 m3 has 3.6 m long, 3 m wide, and 3 m high, The size of the distribution pipe that must be used as channel distribution of clean water in Lembang Bua' Tarrung, namely 3 inches in diameter HDPE type.

REFERENCES

[1] Achore, M., Bisung, E., & Kuusaana, E. D. (2020). Coping with water insecurity at the household level: A synthesis of qualitative evidence. International Journal of Hygiene and Environmental Health, 230, 113598.

[2] Ağbulut, Ü. (2022). Forecasting of transportation-related energy demand and CO2 emissions in Turkey with different

machine learning algorithms. Sustainable Production and Consumption, 29, 141–157.

[3] de Wit, J. A. J., Ritsema, C. J. C., van Dam, J. C. J., van den Eertwegh, G. G., & Bartholomeus, R. P. R. (2022). Development of subsurface drainage systems: Discharge–retention–recharge. Agricultural Water Management, 269, 107677.

[4] Domingo, J. L., & Nadal, M. (2019). Human exposure to per-and polyfluoroalkyl substances (PFAS) through drinking water: A review of the recent scientific literature. Environmental Research, 177, 108648.

[5] Fan, H., Tariq, S., & Zayed, T. (2022). Acoustic leak detection approaches for water pipelines. Automation in Construction, 138, 104226.

[6] Hosseiny, S. H., Bozorg-Haddad, O., & Bocchiola, D. (2021). Water, culture, civilization, and history. In Economical, Political, and Social Issues in Water Resources (pp. 189–216). Elsevier.

[7] Koehler, J., Rayner, S., Katuva, J., Thomson, P., & Hope, R. (2018). A cultural theory of drinking water risks, values and institutional change. Global Environmental Change, 50, 268–277.

[8] Kupel, D. E. (2022). Fuel for growth: Water and Arizona's urban environment. University of Arizona Press.

[9] Leoneti, A. B., & Gomes, L. F. A. M. (2021). A novel version of the TODIM method based on the exponential model of prospect theory: The ExpTODIM method. European Journal of Operational Research, 295(3), 1042–1055.

[10] Quitana, G., Molinos-Senante, M., & Chamorro, A. (2020). Resilience of critical infrastructure to natural hazards: A review focused on drinking water systems. International Journal of Disaster Risk Reduction, 48, 101575.

[11] Smiley, S. L., & Stoler, J. (2020). Socio-environmental confounders of safe water interventions. Wiley Interdisciplinary Reviews: Water, 7(3), e1438.

[12] Soteropoulos, A., Mitteregger, M., Berger, M., & Zwirchmayr, J. (2020). Automated drivability: toward an assessment of the spatial deployment of level 4 automated vehicles. Transportation Research Part A: Policy and Practice, 136, 64–84.

[13] Turner, A. (2021). Planning and development standards. In The cities of the poor (pp. 218–249). Routledge.

[14] Wang, T., Tu, X., Singh, V. P., Chen, X., Lin, K., Lai, R., & Zhou, Z. (2022). Socioeconomic drought analysis by standardized water supply and demand index under changing environment. Journal of Cleaner Production, 347, 131248.

[15] Yee, S. H., Paulukonis, E., Simmons, C., Russell, M., Fulford, R., Harwell, L., & Smith, L. M. (2021). Projecting effects of land use change on human well-being through changes in ecosystem services. Ecological Modelling, 440, 109358.

[16] Ziyaee, M. (2018). Assessment of urban identity through a matrix of cultural landscapes. Cities, 74, 21–31.