Quest Journals
Journal of Architecture and Civil Engineering
Volume 7 ~ Issue 2 (2022) pp: 24-30
www.questjournals.org

Research Paper

Technical Study of Clean Water Network System in Urban Housing
(Case Study: Tugu Bungur Asri Housing, Jember Regency)

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ABSTRACT: *Clean water is one of the important elements in human life. So the supply and distribution of clean water to an area greatly affects the lives of residents in that area. The same is true for the Tugu Bungur housing complex in Patrang District, Jember Regency. Therefore, it is necessary to study the distribution of clean water in residential areas. This study analyzes how much clean water is needed and its distribution. From the results of the study, it is concluded that the water demand is 1,722.5 liters/hour, with a projected population of 265 people. A reservoir capacity of 4,113 liters/hour is required and to raise water into the reservoir, a Shimizu SP 314 BIT pump is used with an electric power of 370 watts and a discharge of 960 lt/hour. above 0.3 m/s, which means that the distribution of clean water in the pipe is uneven, because it meets the minimum flow velocity requirements, which is between 0.3 – 0.6 m/s. It is recommended that the raw water or drinking water used is tested in the laboratory first so that people who consume the water do not get sick due to water pollution.*
KEYWORDS: *Clean Water Needs, Distribution, Housing*

R**eceived 09 Feb, 2022; **R**evised 20 Feb, 2022; **A**ccepted 23 Feb, 2022 © The author(s) 2022. **P**ublished with open access at **www.questjournals.org

I. INTRODUCTION

Clean water is a very important material whose needs are always related to human life. Provision of clean water is not a matter of technology but good water management which includes layers of content, institutions, and communication.[1] The use of clean water is not only limited to household needs, but also involves economic and social service facilities or basic human needs where the need will always increase. Most communities are generally willing to take steps to conserve water, if access to water resources is very limited.[2] Water demand is the amount of water used for human activities, including domestic and non-domestic clean water, irrigation water for both agriculture and fisheries, and water for city flushing. Water needs will not always be the same, but will fluctuate. There are three groups in this case, the first is the average daily requirement, namely the need for water for domestic and domestic purposes including water loss. Usually it is calculated based on the average water requirement of an individual per day calculated from the use of water every hour for a day (24) hours. The second requirement at peak hours is the highest water usage in one day. Water needs at peak hours are calculated based on average daily water needs using a multiplier factor, where peak hour requirements = (1.5 – 2.00 x clean water needs). The maximum daily requirement is the largest amount of water needed in one year. According to the Director General of Human Settlements of the Ministry of Public Works, that the maximum daily need is calculated based on the average daily need using a multiplier factor where the maximum daily requirement is used = (1.15 x clean water requirement) [3]

Domestic water needs are largely determined by the population and per capita consumption. Population trends and population history are used as the basis for calculating domestic water needs, especially in determining the trend of growth rates. Water needs per person per day are adjusted to the standards commonly used and service criteria are based on city categories. In certain categories the water needs per person per day are different. Non-domestic water needs include commercial use, institutional needs and industrial needs. Commercial water demand for an area tends to increase in line with the increase in population and changes in land use. This demand can reach 20 to 25% of the total supply. Institutional needs include water needs for schools, hospitals, government buildings, places of worship and others. Determining the magnitude of this need is quite difficult because it is very dependent on changes in land use and population. The needs for the current industry can be identified, but the needs of the future industry is quite difficult to obtain accurate data. This is due to the various types and kinds of industrial activities.

In supplying water needs, sufficient water sources are needed. One of the sources of water in this world is ground water which is in the ground. . Water that comes from the ground is useful as a source of water for flora, fauna, and humans [4]. In general, groundwater is in the soil layer, from close to the ground surface whose presence is called the shallow water table to those far from the ground surface whose presence is called the deep water level. Groundwater is the amount of water below the earth's surface that can be collected. by wells, tunnels or drainage systems or by pumping. According to Bouwer It can also be called a natural flow that flows to the ground surface through emission or seepage [5]. The layer of soil that is below the soil surface is called the saturated zone and the unsaturated strip is located above the strip to the soil surface where the cavities are filled with water and air. Aquifer storage space, and aquifer filling potential are important determinants for the sustainability of groundwater-based drinking water schemes.[6] Groundwater is water that is stored in saturated lanes and then moves as a flow through rocks and soil layers on the earth until the water comes out as springs, collecting into ponds, lakes, rivers, and the sea. The upper limit of the water-saturated lane is called the water table. [7]

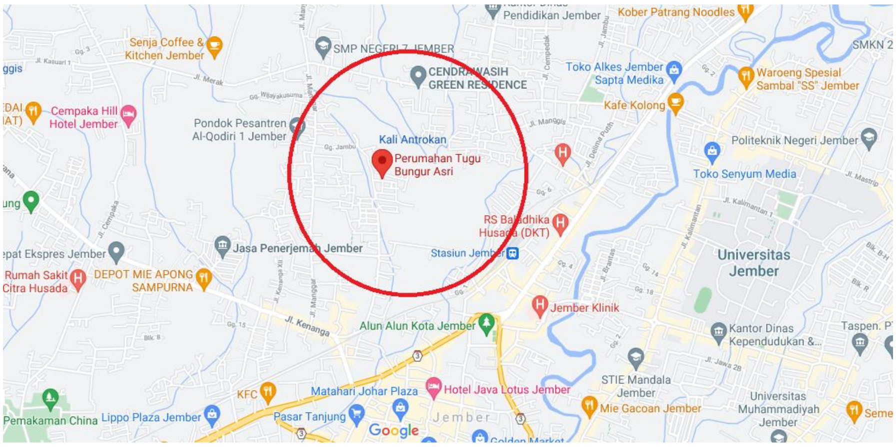
The pipe network system is the main component of the clean water distribution system used to distribute/distribute water to the community. The distribution of clean water can be done in several ways, depending on the topographic conditions that connect water sources with consumers. There are several ways of distributing clean water, namely the gravity system, the pumping system and the combined system of gravity and pumping. [8] The gravity system can be used if the elevation of the water source has a large enough difference with the elevation of the service area, so that the required pressure can be maintained. This system is considered quite economical, because it only takes advantage of the difference in altitude of the location. In this pumping system, a pump is used to increase the pressure needed to distribute water from the distribution reservoir to the consumer. This system is used if the service area is a flat area and there are no hilly areas. In combined systems, reservoirs are used to maintain the required pressure during periods of high usage and in emergency conditions, such as in the event of a fire or energy supply. During periods of low usage, residual water is pumped out and stored in the distribution reservoir. Since the distribution reservoir is used as a water reserve during periods of high usage or peak usage, the pump can be operated at average discharge capacity.

The condition of the service, the availability of clean water in housing, still does not meet the level of clean water demand, so that human efforts are needed in developing a clean water distribution system. The same thing happened to the Tugu Bungur Asri housing which is located in Jember Regency. Based on the above description, it is necessary to technically review the clean water distribution network system.

II. METHODOLOGY

Research Site

The location of the research carried out in the technical study of the clean water network system is in the Tugu Bungur Asri Housing which is located in Patrang District, Jember Regency which is shown in Figure 1. as follows:



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.Figure 1 :Research Location

Research Flowchart

In the technical study of the clean water network in urban housing, this is briefly explained in the flow chart presented in Figure 2 as follows.

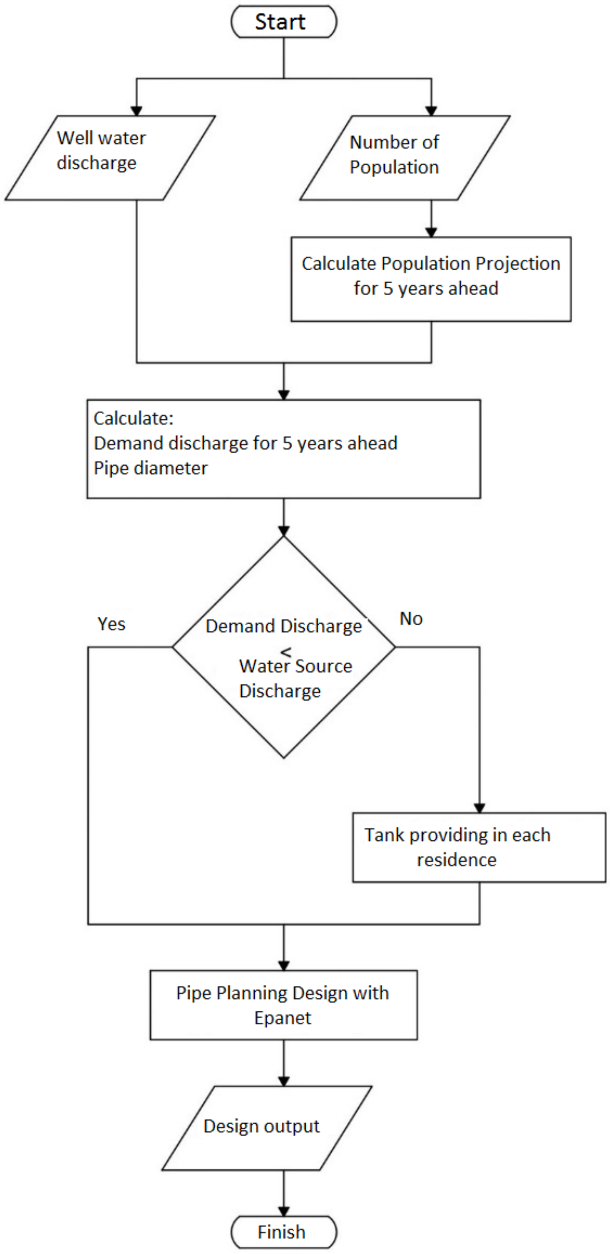

Figure 2. Research Flowchart

Data Collection

In the technical study of the clean water network system at the outskirts of this district, two types of data were used, namely primary and secondary data. The primary data in this study were obtained from the results of direct measurements and observations regarding the existing condition, the size and distance of the drilled wells and reservoirs as well as pipeline routes. While the secondary data used in this study is population data and data on the number of prospective users' families.

Stages of Technical Studies

The stages of technical studies in this research are:

1. Data collection, namely collecting data which in this study is secondary data, namely location maps.
2. Existing Survey, namely surveying the location of raw water wells that will be used as a source of water for distribution to the community.
3. Hydraulics analysis, which is the analysis used to determine the planned discharge to be flowed.
4. Analysis of clean water distribution using Epanet 2.0 software [9]

II. RESULTS AND DISCUSSION

Location and Area Boundaries

Bungur Tugu Asri Housing is a housing complex in Patrang District, Jember Regency. The administrative boundaries of the Tugu Bungur Asri Housing are:

- North side: Cendrawasih Green Residence Perumahan
- South side : Bungur Market Jember
- West : Pondok Pesantren Al-Qodiri Jember
- East side : Baladhika Husada Hospital (DKT)

Population Analysis

The population is very influential on the water needs of the community. Therefore, population data in the location is needed which is presented in Table 1 as follows.

Table 1. Population Analysis

Housing Area	Number of houses		number of people		Total number	
Block 1	9	Unit	5	Person/Unit	45	Person
Block 2	7	Unit	5	Person/Unit	35	Person
Block 3	8	Unit	5	Person/Unit	40	Person
Block 4	9	Unit	5	Person/Unit	45	Person
Block 5	9	Unit	5	Person/Unit	45	Person
Bloc 6	11	Unit	5	Person/Unit	55	Person
					263	Person

Analysis of Needs and Clean Water Distribution Network System

In this network system, a pumping system is used in which a pump is used to increase the pressure needed to distribute water from the distribution reservoir to consumers. This system is used if the service area is a flat area and there are no hilly areas. The main factors in the need and distribution network system for clean water are water demand analysis, analysis and analysis. The need for clean water is very much needed by local residents, in this technical study it was found that the well water discharge and the residents' needs that will be distributed are Well Water Debit = 0.8 lt/s and Clean Water Needs = 90 lt/persin/day. Clean water needs in this study shown in the analysis of water demand which is presented in Table 2 as follows.

Table 2. Water Demand Analysis

Clean Water Needs						
Housing Area	Household Water Needs	Other Needs	Sub Total	Water Loss	Total	Unit
Block 1	4500	1350	5850	1170	7020	lt
Block 2	3500	1050	4550	910	5460	lt
Block 3	4000	1200	5200	1040	6240	lt
Block 4	4500	1350	5850	1170	7020	lt
Block 5	4500	1350	5850	1170	7020	lt
Bloc 6	5500	1650	7150	1430	8580	lt
Total					41340	lt
Total					0.48	lt/s
Total					1722.5	lt/hour

From the results of the projected population, there are 265 people, thus the need for clean water is 1,722.5 liters/hour and water availability is 960 liters/hour by pumping it for 2 consecutive hours.

Calculation of Reservoir Dimensions and Pump Capacity

The clean water transmission system is a piping system from the raw water intake building to the clean water treatment building and then pumped it to the reservoir. The calculation of the Dimensu Resevoir is presented in Table 3 as follows

Table 3. Calculation of Reservoir Dimensions

Hour	Productive Capacity Q = 0.8 L/s	Productive accumulation (m3)	Usage (%)	Usage Per Hour	Usage accumulation	Peak Hour Needs	Hour/Peak Average	Use Product Deviation
00 ; 01	960	960	1	17	17			943
01 ; 02	960	1920	1	17	34			1886
02 ; 03	960	2880	1	115	150			2730
03 ; 04	960	3840	1	115	265			3575
04 ; 05	960	4800	4	461	726			4074
05 ; 06	960	5760	8	922	1647			4113
06 ; 07	0	5760	10	1152	2799			2961
07 ; 08	0	5760	6	691	3490			2270
08 ; 09	0	5760	5	576	4066	3341	668	1694
09 ; 10	0	5760	2	230	4297			1463
10 ; 11	0	5760	2	230	4527			1233
11 ; 12	0	5760	2	230	4758			1002
12 ; 13	960	6720	2	230	4988			1732
13 ; 14	960	7680	6	691	5679			2001
14 ; 15	960	8640	7	806	6486			2154
15 ; 16	960	9600	8	922	7407			2193
16 ; 17	960	10560	15	1728	9135			1425
17 ; 18	960	11520	12	1382	10518			1002
18 ; 19	0	11520	2	230	10748			772
19 ; 20	0	11520	1	115	10863	4032	806	657
20 ; 21	0	11520	1	115	10978			542
21 ; 22	0	11520	1	115	11094			426
22 ; 23	0	11520	1	115	11209			311
23 ; 24	0	11520	1	115	11324			196
							MAX (lt/hour)	4113
							MAX (m3/hour)	4

To raise water from the borehole to the top of the reservoir, a Shimizu SP 314 BIT type pump is used with an electric power of 370 watts and a discharge of 960 liters/hour. From the calculation results obtained reservoir capacity of 4,113 lt/hour > population needs of 1,722.5 lt/hour. So the reservoir capacity is sufficient to meet the needs for the population.
Reservoir capacity : 4113 lt/hour = 4 m3/hour
Length = 2 m
Width = 2 m
Height = 2 m
Volume = 2 x 2 x 2 = 8 m3 > 4 m3 OK

Epanet Analysis Results

For the calculation of the clean water distribution network using Epanet 2.0 software. Epanet's calculation results show that the parameter nodes for each public hydrant node meet the minimum pressure requirements, based on the Transmission and Distribution Pipeline Criteria according to the Minister of Public Works Decree no.18 of 2007, which has a pressure of more than 10 m and less than 75 m. As for the link parameter, it has a velocity that matches the minimum requirements, namely the flow velocity in the pipe between 0.3-0.6 m/s and takes the ratio of the maximum speed requirements of PVC pipes 3.0-4.5 m/s. [10]

The results of the analysis of the calculation of the Tugu Asri Housing pipeline system using the Epane V2.0 program are presented in Table 4, the Time Pattern in Figure 3, and the network map can be seen in Figure 4, and the output is represented in Table 5.

Table 4. Water Demand Analysis

Link				**Junction/Node**		
Pipe	Length (m)	Diameter (mm)	C	Junction	Elevation (m)	Base Demand (l/s)
2	5	32	120	2	13	0.08
3	45	25	120	3	12	0.06
4	40	15	120	4	12	0.07
5	45	25	120	5	12	0.08
6	45	20	120	6	12	0.08
				7	11	0.1
				Recervoir	14	

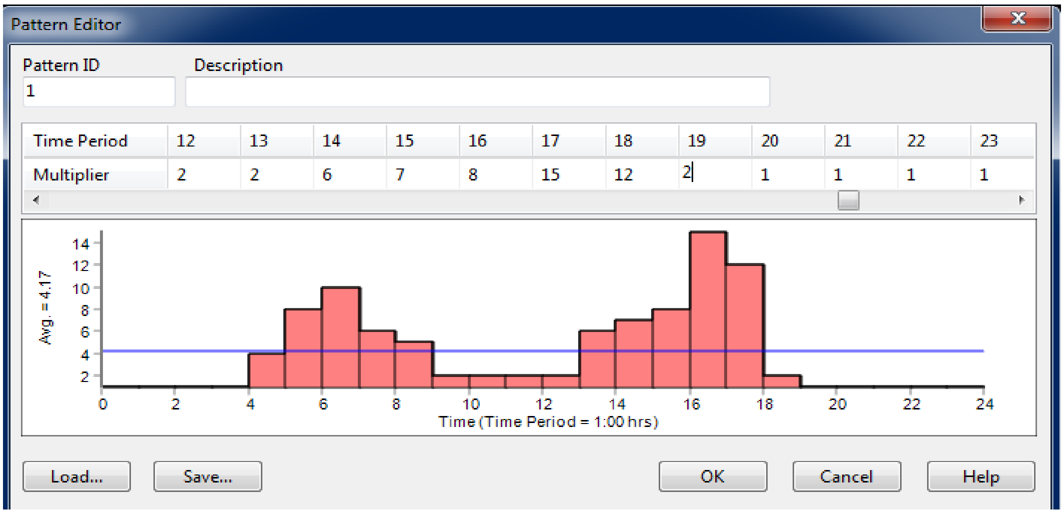

Figure 3 Time Pattern

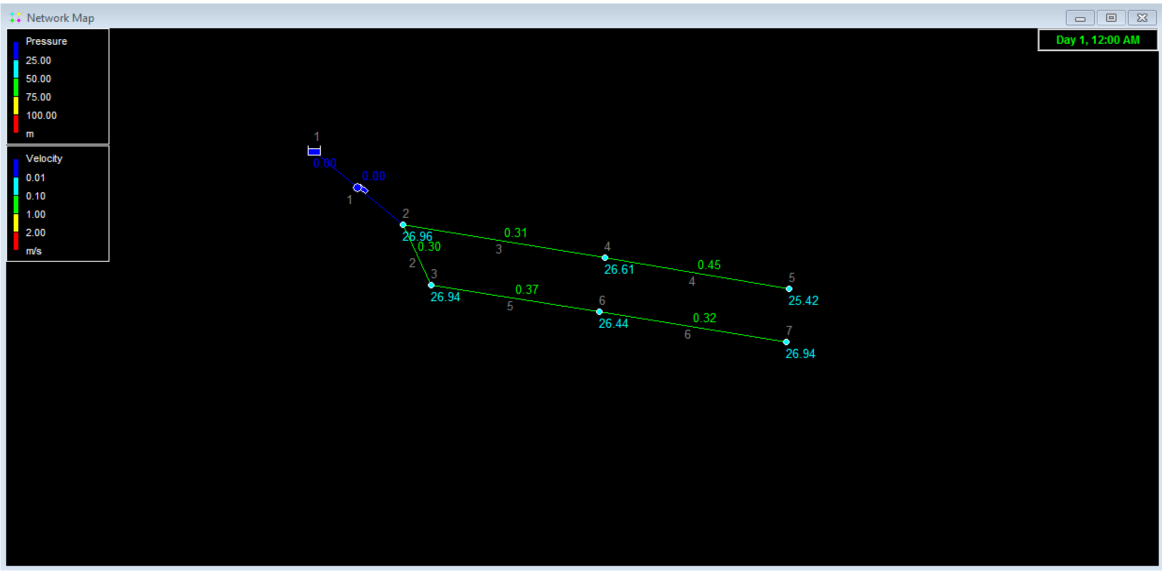

Figure 4. Clean Water Network Map

Table 5. Output Tabel

Network Table - Links				
Link ID	Length m	Diameter mm	Flow LPS	Velocity m/s
Pipe 2	5	32	0.24	0.30
Pipe 3	45	25	0.15	0.31
Pipe 4	40	15	0.08	0.45
Pipe 5	45	25	0.18	0.37
Pipe 6	45	20	0.10	0.32
Pump 1	#N/A	#N/A	0.47	0.00

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From the results of the Epanet analysis above, it can be concluded that the distribution of clean water is smooth, which has met the minimum flow velocity requirements according to the Regulation of the Minister of Public Works Number 18/PRT/M/2007, which is between 0.3 – 0.6 m/s

IV. CONCLUSIONS AND SUGGESTIONS

Conclusion

From the results of the technical study of the clean water network system at the Tugu Bungur Asri housing, Jember district, it can be concluded as follows:

1. From the results of the analysis, it was found that the water demand was 1,722.5 liters/hour, with a population projection of 265 people.
2. Reservoir capacity of 4,113 liters/hour
3. To raise water into the reservoir, a Shimizu SP 314 BIT type pump is used with an electric power of 370 watts and a discharge of 960 lt/hour
4. From the results of EPANET, the following results are obtained:
    a. Pipe 2 diameter 32 mm with a speed of 0.30 m/s
    b. 3 pipe diameter 25 mm with a speed of 0.31 m/s
    c. Pipe 4 diameter 15 mm with a speed of 0.45 m/s
    d. Pipe 5 diameter 25 mm with a speed of 0.37 m/s
    e. Pipe 6 diameter 20 mm with a speed of 0.32 m/s

From these results it is concluded that the distribution of clean water is smooth, because it meets the minimum requirements for flow velocity, which is between 0.3 - 0.6 m/s

Suggestion

For raw water or drinking water, it is expected to conduct water testing in the laboratory first so that people who consume the water do not get sick due to water pollution.

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