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ANALYSIS OF WATER DISTRIBUTION SERVICES BY PERUMDAM TIRTA KHATULISTIWA IN PONTIANAK BARAT SUB-DISTRICT USING EPANET

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Abstract

Freshwater services for the community in Kecamatan Pontianak Barat, divided into various zones, including zone H, consisting of Kelurahan Pal Lima and Kelurahan Sungai Beliung, is served by PERUMDAM Tirta Khatulistiwa, a regional public company of Kota Kota Pontianak. According to the information, the service in zone H could be more optimal because only 63.82% of the population has a pumping capacity of 100 liters/second. Population growth results in a lack of clean water in zone H at peak hours, so it is necessary to analyze water needs for existing conditions and conditions for the next 20 years. Using geometric, arithmetic, and least squares techniques, project the population. The distribution network was analyzed using the Epanet program to ascertain the residential and non-residential water consumption in zone H. For network analysis, there were five separate simulations. There are five different simulations for network analysis. The results of the study found that the demand for clean water for the existing served population was 63.82% at 110.20 liters/second and the existing condition for the served population was 90% at 145.78 liters/second, while the need for clean water in the next 20 years was 341.43. liters/second. The existing pumping capacity can be increased to 200 liters/second in the short term, and 400 liters/second and 40 m of pump head can be achieved in the long run, along with the addition of a booster in zone H with a 200 liters/second pumping capacity and 30 m of the pump head.

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1. Introduction

Water is an essential requirement for human survival; without water, there will be no life on earth. Because of the importance of the need for clean water, it gets the main handling priority because it involves many people's lives. As a basic need, water distribution must be ensured to those who need it so that a clean water supply network follows the needs of both domestic and industrial users (Deriana, 2019).

The provision of clean water in Kecamatan Pontianak Barat is managed by PERUMDAM Tirta Khatulistiwa, established with the stipulation of Regional Regulation Number 03 of 1975. The purpose of establishing this PDAM is to implement community development by improving health and meeting the need for clean water for the community. PERUMDAM Tirta Khatulistiwa serves 13 service zones for all sub-districts in Kota Pontianak with production facilities consisting of IPA Imam Bonjol, IPA Selat Panjang, IPA Sei Jawi, and Parit Mayor. The current installed production capacity of the WTP is 2058 l/second with surface water sources from the Kapuas River and Landak River. The service of PERUMDA Air Minum Tirta Khatulistiwa in the Kecamatan Pontianak Barat is divided into 2 (two) zones, namely, Zone G and Zone H, which can be described as follows:

a. Zone G, serving Sungai Jawi Luar Village and Sungai Jawi Dalam Village with a total customer of 24,251 SR.
b. Zone H, serving Pal Lima Village and Sungai Beliung Village with a total customer of 10,118 SR

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The distribution network of PERUMDA Air Minum Tirta Khatulistiwa for Pontianak Barat District is an old network, more or less from 1959 until now. From the distribution of service zones in Pontianak Barat District, Zone H is the service area that has the lowest customers in Pontianak Barat District. Zone H still has vacant space that could potentially increase private residences and social and commercial facilities for the next 20 years.

Accompanied by an increase in population, the need for clean water also increases from year to year. This causes the distribution of clean water of PERUMDA Air Minum Tirta Khatulistiwa to be not optimal, so there is a leak in the pipe, which results in the cessation of water distribution to the community. Therefore, it is necessary to research the clean water distribution service of PERUMDA Air Minum Tirta Khatulistiwa to benefit the Pontianak Barat District, especially the Pal Lima Village and Sungai Beliung Village, which are included in Zone H..

The problems that will be discussed in this final project are:

a) How much clean water must PERUMDA provide for Tirta Khatulistiwa Drinking Water for the projected population of the next 20 years in Zone H?

b) How is the condition of the clean water distribution network of PERUMDA Air Minum Tirta Khatulistiwa to meet the needs of the community in Zone H for the projected population of the next 20 years?

c) What solutions can be given to the problem of clean water distribution of PERUMDA Air Minum Tirta Khatulistiwa in Zone H?

The objectives of this research are:

a) Knowing the number of water needs that must be distributed by PERUMDA Air Minum Tirta Khatulistiwa in Zone H for the next 20 years.

b) Knowing the condition of the clean water distribution network of PERUMDA Air Minum Tirta Khatulistiwa to meet the needs of the community in Zone H for population projections for the next 20 years.

c) Provide suggestions to overcome problems found in the clean water network of PERUMDA Air Minum Tirta Khatulistiwa in the Zone H, Pontianak Barat,

2. Materials and Methods

Clean water is defined as a type of water-based resource of good quality and is commonly used by humans for consumption or in carrying out their daily activities, including sanitation. Minister of Health Regulation No.32 of 2017 states that what is meant by water is environmental health quality standards for water media for sanitation hygiene purposes, including physical, biological, and chemical parameters, which can be in the form of mandatory parameters and additional parameters.

2.1 Quality Requirements

Quality requirements describe the quality or quality of raw water for clean water. These requirements include physical requirements, chemical requirements, biological requirements, and radiological requirements (Andini, 2016). Water quality management based on Government Regulation of the Republic of Indonesia Number 82 of 2001 states that clean water quality requirements are water quality management carried out to ensure adequate water quality. desired according to its designation in order to remain in its natural condition.

2.2 Quantity Requirements

The quantity required to provide clean water is in terms of the amount of raw water available. This means that the raw water can be used to meet the needs in accordance with the conditions of the area and the number of people to be served. Quantity requirements can also be viewed from the standard of clean water flowed to consumers in accordance with the number of clean water needs (Zamzami, 2018).

2.3 Continuity Requirements

Raw water for clean water must be taken continuously with relatively constant fluctuations in discharge, both during the dry season and the rainy season. Continuity can also mean that clean water must be available 24 hours per day or whenever needed, water needs are available. However, these ideal conditions can hardly be met in every region in Indonesia, so to determine the level of continuity of water use, it can be done by approaching consumer activities to prioritize water use. The priority of water use is for a minimum of 12 hours per day, namely during the hours of life activities, namely at 06.00 - 18.00 WIB.

2.4 Population Projection

To find out the amount of water needed to be served, it is necessary to calculate the projected population to the age of the planning plan. The main basis in determining the population projection is the last population and the current population. In estimating the people, several projection methods are recommended, including (Apriyandi, 2019)

1. Arithmetic Rate of Growth Methode

   The formula used in this method is:

   $$P_n = P_0 + K_a(T_n - T_0) \quad (1)$$

   $$K_a = \left(\frac{P_a - P_1}{T_2 - T_1}\right) \quad (2)$$

2. Geometric Rate of Growth Methode

   The formula used in this method is:

   $$P_n = P_0(1 + r)^n \quad (3)$$

3. Least Square Rate of Growth Methode

The formula used in this method is:

$$Y=a+b.X \tag{4}$$

$$a = \frac{\Sigma Y.\Sigma X^2 - \Sigma X.\Sigma XY}{n.\Sigma X^2 - (\Sigma X^2)} \tag{5}$$

$$b = \frac{n.\Sigma X.Y - \Sigma X.\Sigma Y}{n.\Sigma X^2 - (\Sigma X^2)} \tag{6}$$

The selection of the projection method that will be adjusted to the criteria can be done statistically by using the standard deviation formula (SD) and the correlation coefficient formula (r). The use of the correlation coefficient is intended to show the high degree of relationship between two variables (x and y), therefore the value of the correlation coefficient must be close to 1, while the standard deviation is used to homogenize the data, so from the value of the standard deviation the smallest value is chosen. (Natara, 2018)

$$S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}} \tag{7}$$

$$r = \frac{n\sum XY - \sum X \sum Y}{\sqrt{(nX^2 - (\sum X)^2)(n\sum Y^2 - (\sum Y)^2)}} \tag{8}$$

2.5 Domestic Clean Water Needs

Domestic needs are meant for water needs that are used in private residences to meet daily needs. The unit used is liter/person/day (Zulpiandi, 2018). In Table 1 below shows the amount of domestic debit needed to meet domestic needs is calculated against several factors:

a. The number of people who will be served according to the target of the planning stage in accordance with the service coverage plan.

b. The level of clean water usage is assumed to depend on the category of the area and its population.

Table 1. Domestic Water Supply Planning Category (Source : Ditjen Cipta Karya, Dep. PU,2000)

DESCRIPTION	CITY CATEGORIES BY NUMBER OF POPULATION (SOUL)				
	> 1.000.000	500.000 s/d 1.000.000	100.000 s/d 500.000	20.000 s/d 100.000	< 20.000
	Metro City	Big city	Medium City	Small City	Village
1	2	3	4	5	6
Connection Unit Consumption (liter/org/hari)	190	170	130	100	80
Daily Unit Consumption (liter/org/hari)	30	30	30	30	30
Non-Domestic Unit Consumption	20-30				
Water Loss (%)	20 - 30	20 - 30	20 - 30	20 - 30	20 - 30
Maximum Day Factor	1.1	1.1	1.1	1.1	1.1
Peak Hour Factor	1.5	1.5	1.5	1.5	1.5
Number of Souls SR (jiwa)	5	5	5	5	5
Number of Souls HU (jiwa)	100	100	100	100	100
Remaining Press in Distribution provision (Meter)	10	10	10	10	10
Operating Hours (jam)	24	24	24	24	24
Volume Reservoir (% *Max day Demand*)	20	20	20	20	20

DESCRIPTION	CITY CATEGORIES BY NUMBER OF POPULATION (SOUL)				
	> 1.000.000	500.000 s/d 1.000.000	100.000 s/d 500.000	20.000 s/d 100.000	< 20.000
	Metro City	Big city	Medium City	Small City	Village
SR : HU	50:50 s/d 80:20	50:50 s/d 80:20	80:20	70:30	70:30
Service Coverage (%)	90	90	90	90	70

2.6 Non-Domestic Clean Water Needs

Non-domestic clean water needs are allocated to services to meet the clean water needs of various social and commercial facilities, namely educational facilities, worship, health service centers, government agencies, and commerce. Non-domestic water needs can be calculated by formulating the number of units multiplied by water usage according to non-domestic needs. The amount of water used for standard non-domestic needs refers to Table 2 Kriteria Perencanaan Dirjen Cipta Karya Dinas PU tahun 1996.

Table 2. Category of Non-Domestic Clean Water Planning (Source : Kriteria Perencanaan Dirjen Cipta Karya Dinas PU tahun 1996)

SECTOR	SCORE	UNIT
School	10	liter/murid/hari
Hospital	200	liter/bed/hari
Puskesmas	2000	liter/unit/hari
Mosque	3000	liter/unit/hari
Office	10	liter/pegawai/hari
Market	12000	liter/hektar/hari
Hotel	150	liter/bed/hari
Restaurant	100	liter/tempat duduk/hari
Military Complex	60	liter/orang/hari
Industrial area	0.2 - 0.8	liter/detik/hektar
Tourism Area	0.1 - 0.3	liter/detik/hektar

2.7 Epanet Program in Clean Water Distribution Analysis

Epanet (Environmental Protection Agency Network) is a computer program (model) that performs hydraulic simulations and behavior of water quality in a drinking water distribution pipe network (pressure pipe). A drinking water distribution network consists of pipes, nodes (branches), pumps, water tanks or reservoirs and valves. The outputs generated from the EPANET program include the flow rate in the pipe (lt/s), water pressure from each point/node/junction which can be used as an analysis in determining the operation of installations, pumps and reservoirs. (Rossman, 2000)

The following are some of the uses of the EPANET program, namely:

1. Designed as a tool to determine the development and movement of water and the degradation of chemical elements present in water in distribution pipes
2. Can be used as a basis for analysis and various distribution systems, detailed designs, hydraulic calibration models, residual chlorine analysis and several other elements.
3. Can help determine alternative strategic management in the clean water distribution pipe network system.

Epanet is a hydraulic analysis consisting of:

a. This analysis is not limited by the location of the network location

b .The pressure loss due to friction is calculated using the Hazen Williams, Darcy Weisbach, or Chezy Manning Formulas equations.

c. Besides major losses, minor losses (pressure loss in bends, elbows, fittings, etc.) can be calculated.

d. Constant or variable speed pump model

e. Energy calculations and pump prices Various types of valve models equipped with shut off, check pressure regulating and valves equipped with reservoir speed control of various shapes and sizes.

f. Fluctuation factor in water usage.

g. As the basis for operating the system to control the water level in the reservoir and time.

Epanet also provides water quality analysis:

a. Model the movement of non-reactive material elements through the network at any time.

b. Model of changes in reactive materials in the process of disinfection and residual chlorine.

c. The age model of water flowing in the network

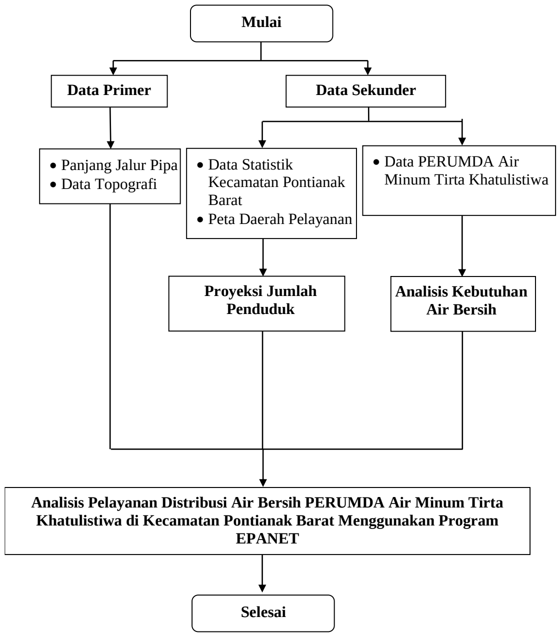
d. Model of chemical reactions as a result of the movement of water and pipe walls

Input Data In Epanet

The data needed in EPANET is very important in the process of analysis, evaluation, and simulation of the EPANET-based water distribution network. The input data required are:

a. Map
b. Node/junction/point of distribution component
c. Elevation
d. Distribution pipe length
e. Pipe inner diameter
f. Type of pipe used
g. Type of source (springs, boreholes, IPAM, etc.)
h. Pump specifications (when using a pump)
i. Load of each node (amount of tapping)
j. Water usage fluctuation factor

2.8 Research Diagram



c) Result and Discussion

The calculation of the projected population is used as the basis for analyzing the need for clean water. In calculating population projections, there are several methods that can be used, including the Arithmetic Method, Geometric Method and Least Square Method. Calculations with this method are carried out over a period of 20 years namely from 2021 to 2041.

Table 3. Recapitulation of the projected population calculation using the Arithmetic Method, Method Geometric dan Method Least Square

Year	Pal Lima Village			Pal Lima Village		
	Method Arithmetic (Jiwa)	Method Geometric (Jiwa)	Method *Least Square* (Jiwa)	Method Arithmetic (Jiwa)	Method Geometric (Jiwa)	Method *Least Square* (Jiwa)
2021	20488.00	20856.20	16675.00	58336.50	58412.77	56747.86
2022	21696.00	22561.26	17473.82	59407.00	59582.50	57538.61
2023	22904.00	24405.72	18272.64	60477.50	60775.66	58329.36
2024	24112.00	26400.97	19071.46	61548.00	61992.71	59120.11
2025	25320.00	28559.33	19870.29	62618.50	63234.14	59910.86
2026	26528.00	30894.15	20669.11	63689.00	64500.42	60701.61
2027	27736.00	33419.85	21467.93	64759.50	65792.06	61492.36
2028	28944.00	36152.03	22266.75	65830.00	67109.56	62283.11
2029	30152.00	39107.57	23065.57	66900.50	68453.45	63073.86
2030	31360.00	42304.74	23864.39	67971.00	69824.26	63864.61
2031	32568.00	45763.29	24663.21	69041.50	71222.51	64655.36
2032	33776.00	49504.59	25462.04	70112.00	72648.76	65446.11
2033	34984.00	53551.75	26260.86	71182.50	74103.57	66236.86
2034	36192.00	57929.78	27059.68	72253.00	75587.52	67027.61
2035	37400.00	62665.72	27858.50	73323.50	77101.18	67818.36

Year	Pal Lima Village			Pal Lima Village		
	Method Arithmetic (Jiwa)	Method Geometric (Jiwa)	Method *Least Square* (Jiwa)	Method Arithmetic (Jiwa)	Method Geometric (Jiwa)	Method *Least Square* (Jiwa)
2036	38608.00	67788.85	28657.32	74394.00	78645.16	68609.11
2037	39816.00	73330.80	29456.14	75464.50	80220.05	69399.86
2038	41024.00	79325.83	30254.96	76535.00	81826.48	70190.61
2039	42232.00	85810.98	31053.79	77605.50	83465.08	70981.36
2040	43440.00	92826.30	31852.61	78676.00	85136.50	71772.11
2041	44648.00	100415.15	32651.43	79746.50	86841.38	72562.86

3.1 Water Demand Analysis

In calculating water demand in Zone H, which includes Pal Lima Village and Sungai Beliung Village, the calculated water needs are domestic water needs and non-domestic water needs for existing conditions and conditions for the next 20 years.

Based on the results of the analysis of clean water needs for existing conditions and projected conditions in 2021 to 2041, the distribution of clean water by PERUMDA Air Minum Tirta Khatulistiwa in Zone H is not sufficient for water needs at peak hours. Based on the data obtained, the amount of water supplied at the Pal Lima Distribution Reservoir is 100 liters/second, in the existing condition with 63.82% of the population served the needs at peak hours for water supply of 110.20 liters/second and in the current condition if it is 90. % of the population is done at peak hours for water supply of 145.78 liters/second, this means that PERUMDA Air Minum Tirta Khatulistiwa still lacks water supply for existing conditions at peak hours. The total water demand at peak hours for projections in 2041 is 341.43 liters/second, this means that PERUMDA Air Minum Tirta Khatulistiwa still lacks 241.43 liters/second to meet water needs at peak hours in 2041.

3.2 Distribution Network Analysis With Epanet 2.2 Program

The simulation of the clean water distribution network with the Epanet program was carried out in the PERUMDA Air Minum Tirta Khatulistiwa in Pontianak Barat District, especially in Zone H, which includes Pal Lima Village and Beliung River with the source of the Pal Lima Distribution Reservoir. The capacity in the Pal Lima Distribution Reservoir is 100 liters/second, and the pump head is 30 m. In this study, 5 network simulations were carried out using the Epanet 2.2 program.

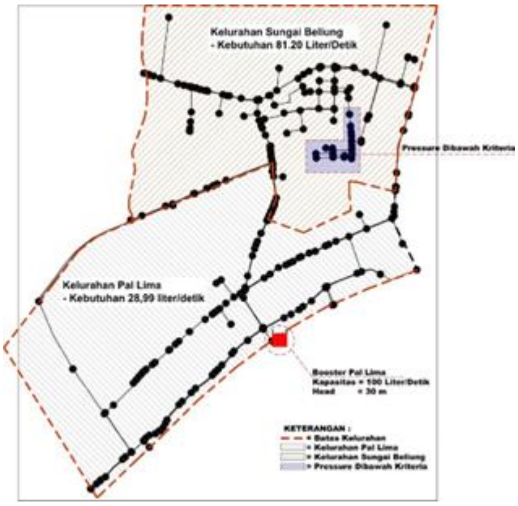
1. Simulation 1, The condition of the need for clean water for existing with a serviced population of 63.82% and using the capacity of the existing pump.
2. Simulation 2, The condition of the need for clean water for existing with 90% of the population served and using the capacity of the exsisting pump
3. Simulation 3, Conditions for clean water requirements for the 2041 projection and using the capacity of the existing pump.
4. Simulation 4, Condition of clean water requirement for exsisting and addition of pump capacity.
5. Simulation 5, Conditions for clean water requirements for the 2041 projection and the addition of pump capacity and the addition of a booster.

From the results of Run using the Epanet 2.2 program in each simulation of the PERUMDA Water Supply Tirta Khatulistiwa distribution network in zone H, the following results can be obtained:

1. Simulation 1

   From the results of the pressure output using the Epanet 2.2 program in the 1st Simulation with the need for clean water for the serviced population of 63.82% and using an existing pump capacity of 100 liters/second and a pump head of 30 m, it can still be found a certain junction point that pressure below 1.0 atm (10 m) in the Sungai Beliung Village area. This is due to the lack of pump capacity to distribute water in existing conditions, so it has not been able to optimize distribution at certain points.

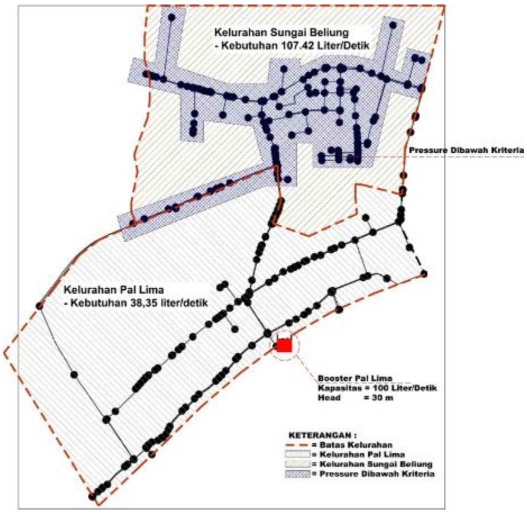
   This problem resulted in the distribution of water pressure at the junction point being low below the criteria. Meanwhile, from the output velocity (velocity) using the Epanet 2.2 program, it can be seen that the existing pipe conditions still have some pipe points that do not meet the criteria. This is due to the large diameter of the pipe resulting in reduced flow velocity in the pipe, and vice versa. The lack of speed in the pipe can result in the pipe not meeting the predetermined criteria.



Picture 1. Situation Description Simulation 1

2. Simulation 2

From the results of the pressure output using the Epanet 2.2 program in Simulation 2 with the need for clean water for the served population of 90% and using an existing pump capacity of 100 liters/second and a pump head of 30 m, then all junction points in Sungai Beliung Village can be obtained. pressure below 1.0 atm (10 m). This is due to the lack of pump capacity to distribute water in existing conditions and the distance from the booster to Sungai Beliung Village which is far away so that it has not been able to optimize water distribution in the Sungai Beliung Village area. Meanwhile, from the output velocity (velocity) using the Epanet 2.2 program, it can be seen that the existing pipe conditions still have some pipe points that do not meet the criteria.



Picture 2. Situation Description Simulation 2

3. Simulation 3

From the results of the pressure output using the Epanet 2.2 program for the 3rd simulation using the same pumping capacity in the existing condition, all junction points for the Sungai Beliung and Pal Lima areas are still under 1.0 atm (10 m) pressure.

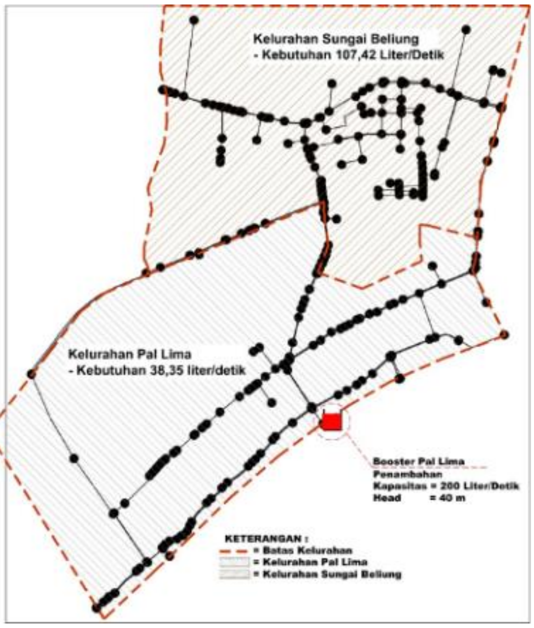
This is due to the increase in the number of customers in 2041 so that the water flow that will be supplied for the projected condition in 2041 also increases, this addition causes the pump capacity in the existing condition to be unable to be used to serve water distribution in the projected condition in 2041. The results of the velocity output (velocity) using the Epanet 2.2 program can result in the 2041 projection pipe conditions that meet and do not meet the criteria.

Picture 3. Situation Description Simulation 3

4. Simulation 4

From the results of the pressure output using the Epanet 2.2 program for the 4th simulation, the results obtained that have met the pressure criteria, namely 10-80 m. The results were obtained by increasing the pumping capacity from 100 liters/second to 200 liters/second. For the pump head, 40 m is used according to existing conditions.

The addition of the pumping capacity will optimize the need for clean water at peak hours and can meet the pressure criteria specified. While the results of the output speed (velocity) using the Epanet 2.2 program by adjusting the changes in pump capacity, it is still obtained results that do not meet the velocity criteria (Velocity), namely (0.3-4.5) m/second.

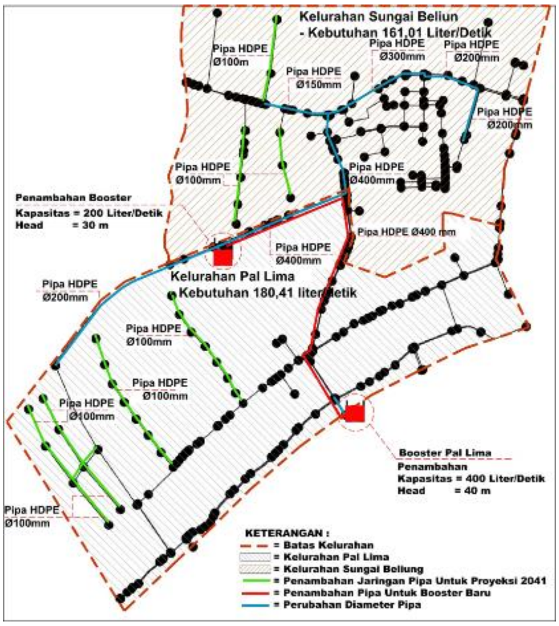


Picture 4. Situation Description Simulation 4

5. Simulation 5

From the results of the pressure output using the Epanet 2.2 program for the 5th simulation, the results that have met the pressure criteria are 10-80 m. The results were obtained by increasing the pumping capacity which was initially 100 liters/second increased to 400 liters/second, the pump head was increased to 40 m. In addition to increasing the pump capacity, it is also necessary to add a booster in zone H with a pumping capacity of 200 liters/second and a pump head of 30 m. So in Zone H there are 2 boosters that will distribute water to Pal Lima Village and Sungai Beliung Village.

The addition of pump and booster capacity in zone H aims to optimize the distribution of water in the area, so that the demand for clean water at peak hours can be met and the pressure criteria determined. the results of the output speed (velocity) using the Epanet 2.2 program by adjusting the changes in pump capacity, we still get results that still need to meet the velocity criteria (Velocity), namely (0.3-4.5) m/sec. Adding pump and booster capacity results in diameter changes and pipe additions.



Picture 5. Situation Description Simulation 5

From the analysis that has been carried out by researchers on 5 simulations of network conditions, the results for simulations 1, 2 and 3 are obtained as information that the current pump capacity or existing conditions are still insufficient to distribute water in 2021 and for the next 20 years, namely in 2041 in Zone H, Meanwhile for simulations 4 and 5 as an evaluation with the addition of pump capacity and the addition of a booster which is expected to help optimize the performance of PERUMDA Air Minum Tirta Khatulistiwa in distributing water in Zone H for existing conditions and projections for the next 20 years especially in Pal Village and Sungai Beliung Village.

d) **Conclusion**

Based on the discussion that has been carried out by the researchers, it can be concluded that the following conclusions can be drawn:

1. The amount of clean water needed by PERUMDA Air Minum Tirta Khatulistiwa in Zone H is for the existing condition with 63,82% serviced population of 110.20 liters/second and the water requirement for existing conditions with 90% served population of 145,78 liters/second, Meanwhile, the need for clean water for the next 20 years is 341.43 liters/second.
2. The condition of the clean water distribution network of PERUMDA drinking water Tirta Khatulistiwa for the estimated population of 20 years in the future if using the current pump capacity, of course it will not be able to distribute water in Zone H, this is due to the current pump capacity of 100 liters/second with pump head 30 while the need for clean water for the next 20 years is 341.43 liters/second. This lack of capacity requires additional capacity and additional boosters to adjust to the increased demand for clean water in the next 20 years, so that it can help optimize the clean water needs of

PERUMDA Air Minum Tirta Khatulistiwa in Zone H, especially Sungai Beliung Village and Pal Lima Village.

3. From the 5 simulations of network conditions that have been carried out, a solution can be found that can help PERUMDA Air Minum Tirta Khatulistiwa , the solutions are as follows:
   a. The solution for the existing conditions in 2021, Can be done as in the 4th simulation, namely, There is a need for an additional pumping capacity from 100 liters/second to 200 liters/second, This is due to the need for peak hours in existing conditions for served residents 63, 82% 110.20 liters/second and the peak hour requirement in the existing condition for the served population is 90% at 145.78 liters/second so it is necessary to increase the pump capacity so that the distribution of clean water in Zone H runs optimally.
   b. The solution for the conditions for the next 20 years in 2041, can be done like simulation 5, namely, it is necessary to increase the pumping capacity from 100 liters/second with a pump head of 30 m to 400 liters/second with a pump head of 40 m. In addition to adding pump capacity, it is also necessary to add a booster in zone H with a pumping capacity of 200 liters/second and a pump head of 30 m. So in Zone H there are 2 boosters that will distribute water to Pal Lima Village and Sungai Beliung Village. The addition of pump and booster capacity in zone H also results in additional and changing pipe diameters. With the addition of pump capacity, the addition of a booster as well as the addition and change of pipe diameter, it is hoped that it will help optimize air distribution in Zone H, especially in Pal Lima Village and Sungai Beliung Village, so that the need for clean water during peak hours can be met.

5. Acknowledgment

The following are suggestions that can be given in this research as follows:

1. It is necessary to increase the pumping capacity of the Pal Lima booster so that the distribution of clean water runs optimally and can meet the needs of peak hours in Zone H, especially Pal Lima Village and Sungai Beliung Village.
2. It is hoped that the results in this study can help optimize the service performance of PERUMDA Air Minum Tirta Khatulistiwa for the distribution of clean water in Zone H.

f) References

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