

Network Development of Clean Water Distribution of Palangka Raya City by Constructed the New Intake in Tumbang Rungan

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ABSTRACT : The coverage of clean water in Palangka Raya is commonly using the raw water transported from Kahayan River. The range of clean water demand in a region as the target study in this research is including the domestic need and non-domestic need. This investigation has the purpose to know the water demand until the year in 2037 as well to get the hydrological condition of water network system. The hydrological simulation of pipe networks is arranged by utilizing the software EPANET 2.0. Moreover, there are 3 (three) alternative models of distribution network development using the new water intake in Tumbang Rungan; 1st (First) model simulation for region of new network development using the water intake of Kahayan River, 2nd model simulation for region where is without the development of new water intake of Tumbang Rungan, and 3rd model simulation of region for new network development using the new water intake of Tumbang Rungan.

The result of this study using the software EPANET 2.0 based on the usage of new water intake in Tumbang Rungan and installation of 2 booster pumps in water distribution network has performed the obtained information that there is the increment of fluid pressure at around 93.77 - 214.39 mka, the flow velocity at range 0.01-2.02 m/s, and density value at 0.08 - 20.3 litre/sec. All in all, the new water intake (600 litre/second) in Tumbang Rungan is not significant in giving an influence to the expansion of water distribution network.

KEYWORDS Network Development, Intake, Hydrological Simulation.

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I. INTRODUCTION

The previous intake has the capacity 200 litre/second which is not able to support the demand of clean water usage. Meanwhile the new intake network in Tumbang Rungan has capacity for 400 litre/second by using the previous distribution networks. This as well is going to implement the new network development in order to support the society demand sustainably and expected to satisfy the clean water access for whole inhabitants in Palangka Raya.

In other hand, Palangka Raya is facing the increment of population growth. The population sum of this city in 2016 was about 267.757 people. This number is been growing from previous year with the population growth rate at 3.03%. The population increment will enhance the amount of clean water usage generally because the increase of water consumption daily.

By observing this condition and evidence, it is important to present the development of distribution system for clean water from PDAM Palangka Raya overall to incline the service quality in giving the water access to clean water demand of people.

II. RESEARCH METHOD

Research Phase

The stages in this research of network model development generally such below:

1. Calculate the projection of population number in Palangkaraya until year 2037.
2. Calculate the serviceable population number and the amount of clean water to people demand until year 2037.
3. Plan the development of distribution network system for clean water in Palangka Raya until year 2037.
4. Calculate the additional networks as the strategic program until year 2037.
5. Analyze the hydrological condition on the system components of clean water distribution that is studied by applying the non-permanent condition model of simulation in software EPANET 2.0.

III. RESULT AND DISCUSSION.

a. The Projection of Population Number

Average of Population Growth Rate can be seen in this Table I such below:

Table I. Data of Population Growth Rate from year 2007 to 2016

Year	Population Number (Individual)	Growth Rate (Individual)	Growth Rate (%)
2007	188.123	2891	1,5 %
2008	191.014	9984	5,2 %
2009	200.998	19964	9,9 %
2010	220.962	3701	1,7 %
2011	224.663	4936	2,2 %
2012	229.599	14901	6,5 %
2013	244 500	7605	3,1 %
2014	252 105	7760	3,1 %
2015	259.865	7892	3,0 %
2016	267.757		
Sum		79634,0	36,3 %
Average of Growth Rate		8848,2	4,0 %

Source: Research Calculation Result

The projection of population number in Palangka Raya from year 2017 to 2027 utilizing the Least Square Method can be observed on Table II below:

Table II. Projection of Population from year 2017 to 2037 per 5 years using Least Square Method

No.	Year	Sum
1	2017	277.802
2	2022	322.641
3	2027	367.480
4	2032	412.319
5	2037	457.158

Source: Research Calculation Result

b. Projection of Clean Water Demand

On the calculation of clean water demand, the certain criteria using in projection of clean water demand is taken on according to the criteria standard of planning of network system for pipe distribution of clean water issued by Department of Regional Civil and Construction. The range coverage of existing service in Palangka Raya at year 2017 was 35.99 % which was based on the number of house connection for clean water (SR) at about 16.400. In this calculation, it is planned to present the increment of range service according to the criteria of MDG at ≥ 80 % in year 2037. The target for service will be at ≥ 80 % by calculating the condition of Palangka Raya that has large area as well significant in elevation of level for land topology.

Table III. The Result of Calculation for Total Clean Water Demand Hasil in Palangka Raya

No	Description	Unit	Year				
			2017	2022	2027	2032	2037
1	Total Domestic Demand	Litre/Sec	104,38	184,85	257,32	341,21	465,62
2	Total No-Domestic Demand	Litre/Sec	23,90	27,73	38,60	51,18	69,84
3	Total Water Demand (domestic + non- domestic)	Litre/Sec	128, 30	212,50	295,90	392,30	535,40

4	Loss Water	%	20,00	20,00	20,00	20,00	20,00
5	Average of Clean Water Demand	Litre/Sec	153,94	255,09	355,10	470,87	642,56
6	Factor of Maximum Day Demand	-	1,10	1,10	1,10	1,10	1,10
7	Maximum Day for Water Demand	Litre/Sec	169,33	280,60	390,61	517,96	706,81
8	Factor of Peak Demand	-	1,50	1,50	1,50	1,50	1,50
9	Peak Clean Water Demand	Litre/Sec	254,0	420,9	585,9	776,9	1060,2

c. Source of Raw Water

Kahayan River is the biggest supplier of source of raw water for PDAM Palangkaraya which is having the large density enough (Q_{max}) for 1261 x 106 m³/year or 40 m³/second with the average density (Q_{Av}) is 20 m³/second and minimum density (Q_{Min}) at about 4 m³/second while the usage of PDAM Gunung Mas and Palangka Raya at around 287.5 litre/second. Theoretically the source of raw water for PDAM is still abundant at about 4000 Litre/second – 287.5 Litre/second = 3712.5 Litre/second.

Table IV. Scenario of Benefit and Drawback Calculation for Water Density Air (UltimateTime) for Palangka Raya year 2017-2037

Explanation	Projection of Water Demand (Litre/Second)				
	2017	2022	2027	2032	2037
Palangka Raya	254,0	420,9	585,9	776,9	1060,2
Capacity of Available Production (Litre/second)	225	225	225	225	225
Shortage(L/second)	29	195,9	360,9	551,9	835,5
Water Sourceto support the Lacking System (Litre/second)	3712,5	3712,5	3712,5	3712,5	3712,5
Remained Capacity of Minimum Kahayan River (Litre/second)	3683,5	3516,6	3351,6	3160,6	2877

d. Alternative Selection of Development

The selection of 3rd alternative simulations that will be taken the best simulation such as 3rd simulation model with the 3 additional booster pumps based on the density condition and fluid pressure. It is been on standard operation to provide the clean water access and been achieving the criteria of clean water distribution planning of PDAM Palangka Raya.

Table IV. Result of Alternative Simulation 1 (one), 2 (two) dan 3 (three)

Alternative	Description of Development	Hydrological Simulation		
		Velocity (m/sec)	Pressure (meter)	Flow (LPS)
Alternative 1 (one)	- Area Development of New Network with Previous Intake Kahayan River	0,001-1,19 > 0,3 = 187 pipes < 0,3 = 2625 pipes	103,80-135,17	0,001 - 9,59
Alternative 2 (two)	- Area without development of New Intake TumbangRungan	0,001-1,59 > 0,3= 147 pipes < 0,3 = 1890 pipes	87,60 – 143,79	0,001 - 9,85
Alternative 3 (three)	- Area Development of New Network with New Intake TumbangRungan.	0,001- 2,27 > 0.3= 380 pipes < 0,3 = 2453 pipes	75,19-165,39	0,001 - 29,15

The pattern of pressure distribution on the network system and plot contour for elevation and pressure is such on Figure II below. The node with color blue is showing a node by having the low pressure on peak time, while red color of node describes the high pressure on ultimate time.

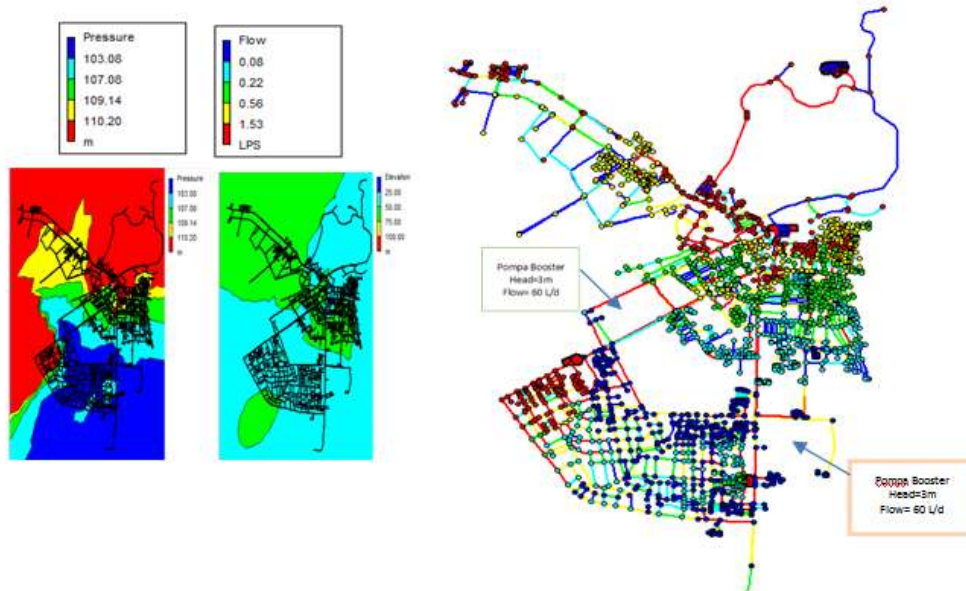


Figure II. The Pattern of Pressure Distribution with Plot Contour on Alternative 3rd Development Model

On the selection of 3rd alternative development needs some important points regarding the density, pressure, and flow velocity. According to the National Rule PU No.18 year 2007, water debit had less than 0.3 litre/second. Therefore, it is required 2 (two) booster pumps at around the area of new network distribution development with pump specification should possess the debit at 60 litre/second and head at about 3 meter such located at YosSudarsoand RTA. Milono Avenue. This is due to the current velocity of installation point of booster pump is highest from area development with value at 0.10 lps (litre per second) and 0.09 lps.

The range of pressure on distribution network system of Simulation on EPAANET 2.0 (on peak time) is on 17.00 WIB (West Indonesian Time) that around 75.19- 165.39 meter followed by the highest pressure is on 165.39 meter. It is been found on Node n456 where is located on near of new intake center of TumbangRungan, while the lowest pressure is positioning on 75.19 m and on Node n23 (this location is at G.Obos Avenue) with the distance from center intake service is about ± 2 km. The condition such this is able to be found on the development area with loss of high pressure value significantly.

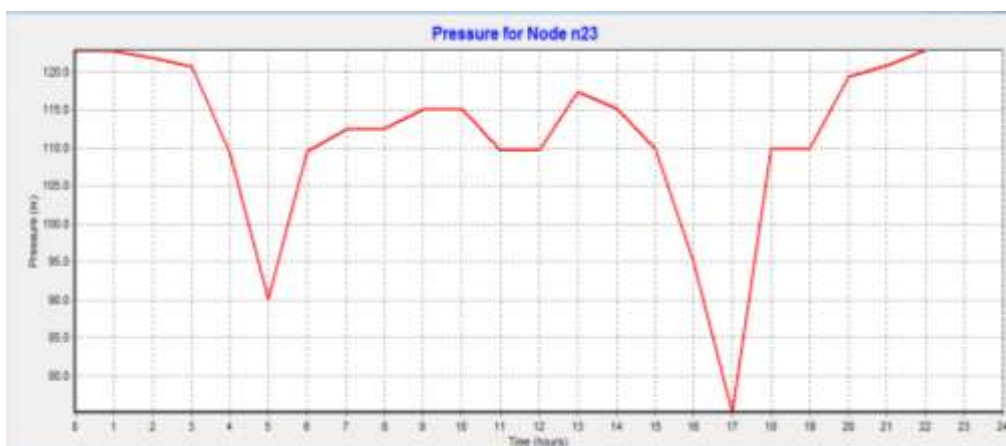


Figure III. The Loss of High Pressure Value on the 3rd Alternative Development Model

The distributed density on network system of PDAM Palangka Raya obtained from the simulation using EPANET 2.0 with additional booster pumps is about 0,001 – 29.15Litre/second (LPS). The biggest

density is on the network adjacent to the center service of intake canal (pipe 1135), however the lowest density is positioning on far from the center service of intake.

The water velocity on the network system of 3rd alternative development model with additional booster pump is at 0,001- 2.27 m/s. For the water velocity over than 0.3 m/s, there are 380 pipes network with water velocity is less than 0.3 m/s. Furthermore, there are 2453 pipes having the water velocity less than 0.3 m/s. This does not be change comparing to previous condition which is before adding the booster pump in the development area with more number of pipes.

IV. CONCLUSION

The conclusion of this research is such below;

1. The projection of water demand in Palangka Raya on the peak time until year 2037 is about 1060.2 litre/second while the projection of water usage for development area of network distribution shows at 6,20 liter/second.
2. For the development area of 1st alternative simulation model using EPANET 2.0 has the range of pressure at about 103,80-135,17 m. The value of water velocity as the result of calculation is been between 0,001- 1,19 meter/second. Other parameter such water density on network distribution of PDAM Palangka Raya provides the range from 0,001 to 9,59 litre/second (LPS).
3. For the development area of 2nd alternative simulation model using EPANET 2.0 has the range of pressure at about 87.60 – 143.79 m. The value of water velocity as the result of calculation is between 0.001-1.59 meter/second. The water density on network distribution of PDAM Palangka Raya provides the range from 0.001 to 9.85 litre/second (LPS).
4. For the development area of 3rd alternative simulation model using EPANET 2.0 has the range of pressure at about 86.48-165.39 m. The value of water velocity as the result of calculation is between 0.001- 2.27 meter/second. The water density on network distribution of PDAM Palangka Raya provides the range from 0.001 to 9.52 liter/second (LPS).
5. The 3rd alternative development is the development of new intake TumbangRungan with new network which is selected as the basic consideration for built system for instance. This is accommodated the strategic plan of development for clean water distribution of PDAM Palangka Raya. The addition of density production by 600 litre/second in new intake TumbangRungan is not significantly influencing the expansion of water distribution network.
6. After the installation of 2 booster pumps on development location of 3rd alternative model in simulation of EPANET 2.0, it performs the increment of pressure range between 75.19- 165.39 meter, density with range at 0.001 – 29.15 Litre/second (LPS) and the water velocity is 0.001- 2.27 m/s.

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