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THE NEEDS AND AVAILABILITY ANALYSIS OF CLEAN WATER IN THE MEBIDANG SPAM SERVICES IN MEDAN MARELAN REGION

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ABSTRACT

Analysis of clean water needs and availability in Medan Marelan District is needed to ensure the adequacy of SPAM services along with population growth and increasing domestic and non-domestic water consumption in the future. This study aims to identify the projection of clean water needs and availability that can be accessed by the community in Medan Marelan District over the next 10, 30, and 50 years. The analysis was conducted using a quantitative descriptive approach, utilizing secondary data sourced from relevant agencies and applying arithmetic projection methods to estimate population growth, as well as the increase in both domestic and non-domestic water demands. The calculation results show that the need for clean water in the area will increase significantly from 2024 to 2075, with a total need reaching 680.27 liters per second in 2075. However, the availability of clean water from the Mebidang Regional Drinking Water Supply System (SPAM), with a capacity of 1,100 liters per second, is estimated to still be able to meet these needs during the observed period. This surplus condition provides a strong basis for policy planning and sustainable water resource management in Medan Marelan District.

Keyword: *Availability, Clean Water, Needs.*

1. INTRODUCTION

The most essential element for the survival of all life on Earth is water [1]. Clean water is a basic human need, the quality of which has been regulated in the Regulation of the Minister of Health of the Republic of Indonesia No. 416/MENKES/PER/IX/1990 concerning Clean Water Quality Requirements. In this regulation, water that is considered to meet health standards must be odorless, colorless, tasteless, clear, and free from germs and hazardous substances. Along with population growth, people's dependence on clean water continues to increase, including as part of their daily lifestyle. Clean water plays an important role in maintaining human health and is one of the main needs for all living things. For humans themselves, clean water is used in various daily activities, such as washing, cooking food and drinks, bathing, and other household needs [2].

Clean water is usually defined as water that is suitable for use as raw water for drinking and is also suitable for bathing, washing, and toilets. However, clean water should not be drunk directly, because it must be cooked or boiled until boiling. The Ministry of Health has made a detailed definition of clean water, namely clean water is water that is used for daily needs and will be used as drinking water after being cooked first. Clean water meets the requirements of a drinking water supply system with physical, chemical, biological, and radiological quality so that when consumed it does not cause side effects [3]. Medan Marelan District, as one of the districts with a fairly large population in Medan City, faces challenges in meeting clean water needs.

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Based on data, the population of Medan Marelan in 2021 has reached more than 190,000 people, with domestic water needs of 341.37 liters/second and non-domestic water needs of 68.27 liters/second [2].

The need for clean water in an area is not only determined by the population, but is also influenced by the technical planning standards set by the government [4]. Based on the Clean Water Planning Criteria Table from the Directorate General of Human Settlements (2000), the calculation of water needs refers to the category of cities based on population, where Medan Marelan District is included in the category of medium cities with a population of between 100,000 and 500,000 people. In this category, water consumption per house connection (SR) is set at 130 liters/person/day, while water consumption for public hydrant units (HU) is 30 liters/person/day, with additional non-domestic needs of 20–30% of domestic needs. In addition, the water loss factor is also an important component, with an estimate of between 20–30%, which must be taken into account in the total needs estimate. This criterion is an important basis in calculating the projection of clean water needs in Medan Marelan District for the next 10, 30, and 50 years, so that the Mebidang SPAM planning can adjust its service capacity to the real needs of the community and anticipate spikes in water demand in the future.

Table 1. Clean Water Planning Criteria

No.	Description	City Categories Based on Population				
		>1.000.000	500.000s/d 1.000.000	100.000 s/d 500.000	20.000s/d 100.000	<20.000
		Metro	Big	Medium	Small	Village
1	Household connection unit (SR) consumption l/o/h	190	170	130	100	80
2	Public hydrant unit (HU) consumption l/o/h	30	30	30	30	30
3	Non-domestic unit consumption l/o/h (%)	20-30	20-30	20-30	20-30	20-30
4	Water loss (%)	20-30	20-30	20-30	20-30	20-30
5	Maximum day factor	1,1	1,1	1,1	1,1	1,1
6	Peak hour factor	1,5	1,5	1,5	1,5	1,5
7	Number of people per SR	5	5	5	5	5
8	Number of people per HU	100	100	100	100	100
9	Residual pressure in distribution supply (mka)	10	100	100	100	100
10	Operating hours	24	24	24	24	24
11	Reservoir volume (& max day demand)	20	20	20	20	20
12	SR : HU	50:50 s/d 80:20	50:50 s/d 80:20	80:20	70:30	70:30
13	Service coverage (%)	*) 90	90	90	90	**) 70

Description: *) = 60% piping, 30% non-piping
**) = 25% piping, 45% non-piping
Source: Directorate General of Human Settlements, Department of Public Works, 2000

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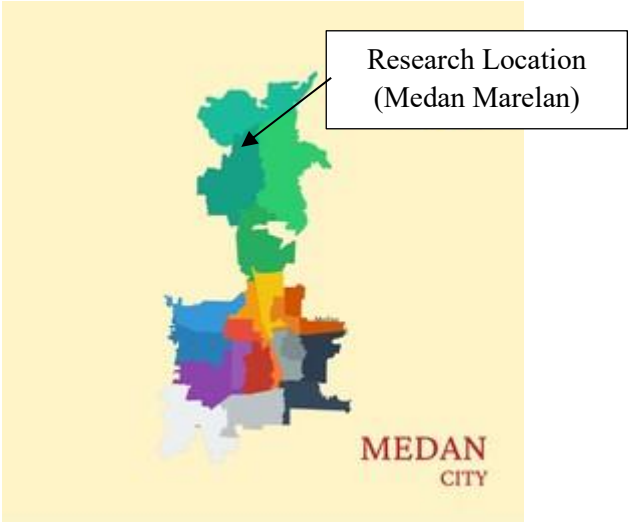
Data shows that the need for clean water in Medan City continues to increase from 2018 to 2025, and this trend is predicted to continue. Projections of water needs are usually calculated using arithmetic or geometric methods that take into account long-term population growth. However, the availability of clean water from PDAM is currently unable to fully meet these needs, so some people are forced to use alternative water sources that do not necessarily meet health standards. In addition, challenges such as climate change, limited raw water resources, and the risk of environmental pollution increase the potential for a clean water crisis in the future, both in terms of quantity and quality [5].

As part of the solution, the Regional Drinking Water Supply System (SPAM) Mebidang (Medan-Binjai-Deli Serdang) is present as a government effort to address the gap between the need and availability of clean water in the region. The service area of SPAM Mebidang covers 10 sub-districts in Medan City (Medan Marelan, Medan Deli, Medan Labuhan, Medan Petisah, Medan Helvetia, Medan Sunggal, Medan Barat, Medan Timur, Medan Tuntungan, and Medan Selayang), 2 sub-districts in Binjai City (North Binjai and East Binjai), and 1 sub-district in Deli Serdang Regency (Hamparan Perak). Therefore, this study aims to identify the projection of clean water needs and availability that can be accessed by the community in Medan Marelan District in the next 10, 30, and 50 years, as a basis for policy planning and sustainable water resource management.

2. RESEARCH METHODOLOGY

The analysis was conducted using a quantitative descriptive approach, utilizing secondary data sourced from relevant agencies and applying arithmetic projection methods to estimate population growth, as well as the increase in both domestic and non-domestic water demands.

This research will be conducted in Medan Marelan District, Medan City, with an area of 23.82 km2 which is geographically located at coordinates 3°43'43" North Latitude and 98°38'30" East Longitude. The height of the Medan Marelan District area is estimated to range from 0.5 to 5 meters above sea level. The research will be conducted in June 2025. The research location map can be seen in Figure 1 below:



Sources: Processed by Researcher, 2025

Figure 1. Map of Medan City (id.wikipedia.org)

Data collection in this study was conducted secondary through documentation and literature studies, by reviewing various relevant documents, reports, and scientific publications. Data sources include historical population data and population projections of Medan Marelan District from BPS or regional planning documents, scientific journals related to clean water needs analysis, as well as regulations and technical standards such as SNI which regulate per capita water needs standards, non-domestic coefficients, and water loss rates. These data are the basis for calculating water needs projections using arithmetic, geometric, or standard deviation methods.

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The analysis steps to be taken include:

1. Population Growth Projection

According to Simanjuntak [2] in the Standard Criteria for Designing Clean Water Supply Systems, the planned population growth rate can be used to predict the population in the future.

a. Arithmetic Method: Population projection using the arithmetic method assumes that the population in the future will increase by the same amount each year. The projection results will be in the form of a straight line [6]. The formula used is:

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

Where is the population growth rate $r = \frac{\left(\frac{P_n}{P_0}\right)-1}{t}$

Information :

P_n = population in year n (people)
P_0 = population in base year (people)
r = population growth rate

b. Geometric Method: Using the assumption that the population will increase geometrically, population projection is done geometrically. This is done using a compound calculation basis. The population growth rate is assumed to be the same for each year [7]. The formula used is:

$$P_n = P_0 \times (1 + r)^n \quad (2)$$

Information :

P_n = population in year and (people)
P_0 = population in the initial year (people)
n = time period in years
r = population growth rate (%)

c. Domestic Water Requirements: Calculated based on population projections and standard water requirements per capita (e.g. in liters/person/day).

1) Clean Water Needs for Each House Connection (SR)
SR = Number of residents x SR consumption x SR Percentage
$S1 = \frac{Cakupan\ SR \times Std\ SR}{86400\ dtk}$ (3)
2) Water requirements for public hydrants (HU)
$Sb = \frac{Cakupan\ HU \times Std\ HU}{86400\ dtk}$ (4)
HU = population x HU consumption x HU percentage

d. Non-Domestic Water Requirements: Calculated based on a certain percentage of domestic water requirements or standard assumptions of water use for the non-domestic sector.
1) Non-domestic water requirement (Kn) = Kn=30% ×(S1+Sb) (5)
2) Water loss (Lo) = Lo=20% ×(S1+Sb) (6)
3) Total Water Requirement (Pr) = Pr=(S1+Sb)+Kn+Lo (7)
4) Maximum Daily Requirement (Ss) = Ss=1.1×Pr (8)
5) Peak Hour Requirement = Su=1.5 ×Pr (9)

e. Clean Water Needs Analysis: Calculation of clean water needs will be carried out based on population projection data and per capita water requirement standards, as well as non-domestic coefficients and percentage of water loss.

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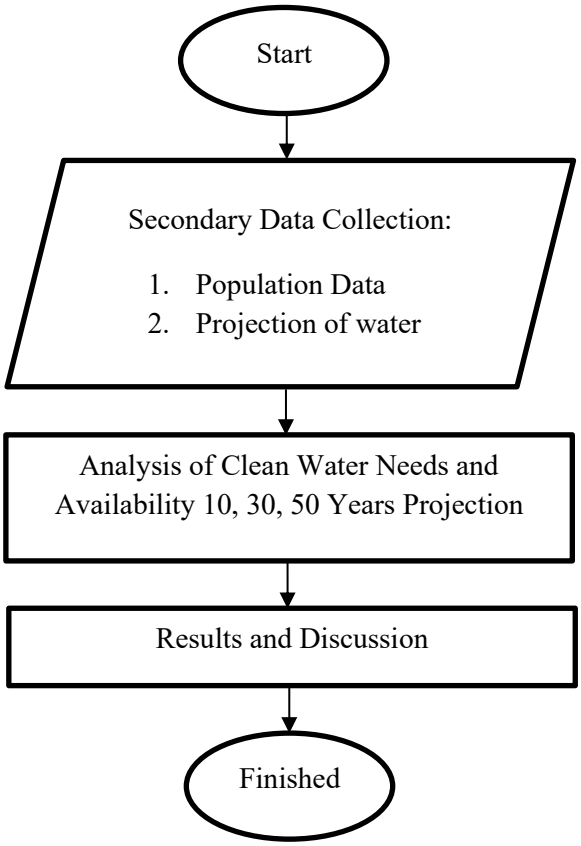
The analysis flow contains the stages that will be carried out in completing this research. The analysis flow of clean water needs and availability in the Medan Marelan SPAM MEBIDANG area (Medan-Binjai-Deli Serdang).



Sources: Processed by Researcher, 2025

Figure 2. Research Flow

3. RESULTS AND DISCUSSION

3.1 Population Projection Analysis

a. Population Data

Table 2. Data on the Number of SPAM Mebidang Population

Year	Year Population (People)
2014	156394
2015	162267
2016	167984
2017	169342
2018	172456
2019	175382
2020	182515
2021	186391
2022	190940
2023	189469

Source: SPAM, 2023

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b. Population Growth Projection Analysis Using Arithmetic Methods

Table 3. Population Growth Projection Arithmetic Method

Year	Year Population (People)	Ka	P_t	$(Pi - Pt)^2$
2014	156394	0	156394	0
2015	162267	5873	160069	4831204
2016	167984	5717	163744	17977600
2017	169342	1358	167419	3697929
2018	172456	3114	171094	1855044
2019	175382	2926	174769	375769
2020	182515	7133	178444	16573041
2021	186391	3876	182119	18249984
2022	190940	4549	185794	26481316
2023	189469	-1471	189469	0
Total	1753140			
Average		3675		
Standard Deviation				3000,698035

Source: Test Results, 2025

c. Population Growth Projection Analysis Using Geometric Methods

Table 4. Population Growth Projection Geometric Method

Year	Year Population (People)	Kg	P_t	$(Pi - Pt)^2$
2014	156394	0	156394	0
2015	162267	0,036864662	159763,5313	6267355,302
2016	167984	0,03462561	163205,6597	22832535,72
2017	169342	0,008051602	166721,9493	6864665,818
2018	172456	0,018221793	170313,9978	4588173,518
2019	175382	0,016824321	173983,4375	1955977,096
2020	182515	0,039865909	177731,9358	22877703,05
2021	186391	0,021014256	181561,1961	23327006,02
2022	190940	0,024112625	185472,9583	29888545,03
2023	189469	-0,00773382	189469	0
Total	1753140			
Average		0,021316329		
Standard Deviation				3443,863551

Source: Test Results, 2025

d. Standard Deviation Calculation Results

Table 5. Results of Standard Deviation Calculation

Metode	Standar Deviasi
Aritmatika	3000,698035
Geometrik	3443,863551

Source: Result of Calculation, 2025

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Based on Table 5, the method chosen to be used is the Arithmetic Method. In accordance with research conducted by Haryati (2024) [8] where the arithmetic method was chosen because it has the smallest standard deviation value compared to other methods. The selection of the method with the largest standard deviation is intended to describe the highest population growth scenario in the next 50 years.

The annual population projection during the period is then calculated using Equation 1, with the results presented in Table 6.

e. Population Growth Projection for the Next 50 Years

Table 6. Population Growth Projections for the Next 50 Years

Year	Year Population (People)
2024	193144
2025	196819
2027	204169
2028	207844
2029	211519
2030	215194
2035	233569
2045	270319
2055	307069
2065	343819
2075	380569

Source: Test Results, 2025

3.2 SR and HU Service Coupon

Coverage of clean water services through house connections (SR) and public hydrants (HU) is the main indicator in assessing community access to clean water services [9]. In Medan Marelan District, the distribution of services is still uneven, so it is important to know the percentage of the population that has been served through the pipe network and public hydrants. This analysis also considers the ratio of the number of people per SR and HU and the SR:HU comparison according to national planning standards, in order to identify the potential for increasing service coverage in the future.

Based on the clean water planning criteria from the Directorate General of Human Settlements, Department of Public Works in 2000, Medan Marelan is included in medium city planning where the data:

1) Service Coverage: 90% of the total population
2) Domestic Consumption Distribution:
3) House Connection (SR):
   a) Percentage: 80%
   b) Standard water requirement: 130 liters/person/day
4) Public Hydrant (HU):
   a) Percentage: 20%
   b) Standard water requirement: 30 liters/person/day
2) Non-Domestic Consumption: 30% of total domestic requirement
3) Maximum Daily Factor: 1.1
4) Peak Hour Factor: 1.5
5) Water Loss: 20%

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Table 7. SR and HU Service Coverage

Year	Year Population (people)	Service Coverage (CP)	SR Coverage (people)	HU Coverage (people)
2024	193144	173829,6	139063,68	34765,92
2025	196819	177137,1	141709,68	35427,42
2027	204169	183752,1	147001,68	36750,42
2028	207844	187059,6	149647,68	37411,92
2029	211519	190367,1	152293,68	38073,42
2030	215194	193674,6	154939,68	38734,92
2035	233569	210212,1	168169,68	42042,42
2045	270319	243287,1	194629,68	48657,42
2055	307069	276362,1	221089,68	55272,42
2065	343819	309437,1	247549,68	61887,42
2075	380569	342512,1	274009,68	68502,42

Source: Test Results, 2025

3.3 Analysis of Water Needs for the Next 10, 30, and 50 Years

Projections of future clean water needs are greatly influenced by population growth and water consumption patterns [10]. In this context, an analysis was conducted to calculate domestic and non-domestic clean water needs for the next 10, 30, and 50 years.

The calculation uses projection methods such as arithmetic, taking into account the variables of water consumption per capita, maximum day factors, peak hours, and percentage of water loss.

The results of this analysis are an important reference in planning the capacity of the clean water supply system to accommodate future needs. The following are the results of the analysis shown in table 8, namely:

Table 8. Calculation of Water Requirements for the Next 10, 30, and 50 Years

	Kebutuhan Air (L/dtk)							
Year	**SR Water Requirements (S1)**	**Water Requirement HU (Sb)**	**Domestic Water Needs (S1+Sb)**	**Non-Domestic Water Needs (Kn)**	**Water Loss (Lo)**	**Total Water Requirement (Pr)**	**Max Daily Needs (Ss)**	**Peak Hour Demand (Su)**
2024	209,24	12,07	221,31	66,39	57,54	345,24	379,77	517,87
2025	213,22	12,30	225,52	67,66	58,64	351,81	387,00	527,72
2027	221,18	12,76	233,94	70,18	60,83	364,95	401,45	547,43
2028	225,16	12,99	238,15	71,45	61,92	371,52	408,67	557,28
2029	229,15	13,22	242,37	72,71	63,02	378,09	415,90	567,14
2030	233,13	13,45	246,58	73,97	64,11	384,66	423,13	576,99
2035	253,03	14,60	267,63	80,29	69,58	417,50	459,26	626,26
2045	292,85	16,89	309,74	92,92	80,53	483,20	531,51	724,79
2055	332,66	19,19	351,85	105,55	91,48	548,89	603,77	823,33
2065	372,47	21,49	393,96	118,19	102,43	614,58	676,03	921,86
2075	412,28	23,79	436,07	130,82	113,38	680,27	748,29	1020,40

Source: result of calculation, 2025

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Based on Table 8, it can be seen that the need for clean water in Medan Marelan District has increased significantly in the next 10, 30, and 50 years. In 2024, the total water requirement was recorded at 345.24 liters/second and continued to increase to reach 680.27 liters/second in 2075. This requirement includes water for house connections (SR), public hydrants (HU), domestic and non-domestic needs, and takes into account water loss in the distribution system.

In addition, if considering the maximum day and peak hour factors, water needs can increase to 1,020.40 liters/second in 2075. These data show the importance of long-term planning and sustainable water resource management to anticipate the surge in water needs along with population growth and community activities.

3.4 Analysis of Clean Water Availability for the Next 10, 30, and 50 Years

In addition to the need, the availability of clean water is also a crucial aspect that must be analyzed in long-term planning. This study evaluates the potential of water resources that can be utilized by SPAM Mebidang to meet the needs of the community in Medan Marelan District. The analysis includes an estimate of the available raw water discharge and the processing and distribution capacity of the existing system.

By comparing the projection of availability to needs in the next 10, 30, and 50 years, the potential gaps that may occur and anticipatory strategies that need to be prepared can be identified. The raw water source discharge is taken from SPAM Mebidang with a discharge of 1100 L/sec. The following are the results of the analysis shown in table 9, namely:

Table 9. Analysis of Clean Water Availability in the Next 10, 30, and 50 Years

Year	Water Availability (L/sec)	Water Requirement (L/sec)	Water Balance (L/sec)	Information
2024	1100	345,24	754,76	Surplus
2025	1100	351,81	748,19	Surplus
2027	1100	364,95	735,05	Surplus
2028	1100	371,52	728,48	Surplus
2029	1100	378,09	721,91	Surplus
2030	1100	384,66	715,34	Surplus
2035	1100	417,50	682,50	Surplus
2045	1100	483,20	616,80	Surplus
2055	1100	548,89	551,11	Surplus
2065	1100	614,58	485,42	Surplus
2075	1100	680,27	419,73	Surplus

Source: result of calculation, 2025

Table 9 shows that the availability of clean water in the Medan area, especially in the Mebidang SPAM service which covers 10 sub-districts, of which Medan Marelan is one of the sub-districts. In this analysis, the availability of clean water in Medan City, especially in Medan Marelan, is still sufficient for the next 50 years. With a water supply capacity of 1,100 liters per second, the need for water every decade remains below the availability threshold. In 2024, a surplus of 754.76 liters per second was recorded, and although the need continues to increase, in 2075 the surplus was still recorded at 419.73 liters per second. This shows that, if the supply capacity is maintained, this area will not experience a shortage of clean water in the long term. However, periodic monitoring and evaluation are still needed to ensure the match between supply and demand along with population growth and changes in consumption patterns.

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4. CONCLUSION

The conclusion of this study shows that the availability of clean water in Medan Marelan District until 2075 is estimated to remain in surplus even though there is a significant increase in demand along with population growth and community activities.

The current water supply capacity of 1,100 liters per second is still able to meet the projected need for clean water in the next 10, 30, and 50 years. This provides a strong foundation for policy planning and sustainable management of water resources in the region. However, in order for this condition to be maintained, water resource management must be carried out efficiently with continuous monitoring and adjustment to changes in needs and infrastructure conditions.

The Mebidang Regional SPAM covers 10 districts including Medan Marelan with a discharge capacity of 1,100 L/sec. In this study, in the water availability analysis section, the discharge figure cannot be used as a reference for the needs of one district, because the Mebidang SPAM discharge is intended to meet the water availability of the 10 districts served. Therefore, the author recommends that a specific study is needed to analyze the need and availability of water in the entire coverage area of SPAM Mebidang which includes 10 sub-districts, namely Medan Marelan, Medan Deli, Medan Labuhan, Medan Petisah, Medan Helvetia, Medan Sunggal, Medan Barat, Medan Timur, Medan Tuntungan, and Medan Selayang. The study is expected to provide up-to-date data on water availability in each sub-district served.

5. REFERENCES

[1] A. Saputra and R. Gunawan, “Analisis Kebutuhan dan Ketersediaan Air Bersih Dusun II Desa Teladan Kecamatan Curup Selatan Proyeksi 2027,” *STATIKA: Jurnal Teknik Sipil*, vol. 8, no. 1, pp. 46–54, 2022.

[2] S. Simanjuntak, E. O. Zai, and ichael H. Tampubolon, “Analisa Kebutuhan Air Bersih di Kota Medan Sumatera Utara,” *Jurnal Visi Eksakta*, vol. 2, no. 1, pp. 119–128, 2021.

[3] Nofrizal and R. A. Saputra, “Analisis Kebutuhan dan Ketersediaan Air Bersih di Wilayah Kecamatan Tigo Nagari Kabupaten Pasaman,” *Rang Teknik Journal*, vol. 4, no. 2, pp. 276–281, 2021.

[4] M. Darmasetiawan, *Sistem Perpipaan Distribusi Air Minum*, 1st ed. Jawa Barat: PT. Kimhsafi Alung Cipta, 2024.

[5] R. D. Lufira, U. Andrawayanti, and N. Z. Fitriani, *Krisis Sumber Daya Air Pendekatan Inovatif dan Solusi Berkelanjutan*, 1st ed. Magetan: CV. AE Media Grafika, 2025.

[6] F. B. Alifianto, R. Haribowo, and M. Sholichin, “Studi Evaluasi Peningkatan Sistem Distribusi Air Bersih PDAM Sidoarjo Unit Kedunguling Menggunakan Software Watercad V8i,” *Jurnal Teknologi dan Rekayasa Sumber Daya Air*, vol. 5, no. 1, pp. 571–582, 2025.

[7] D. S. Pratiwi, A. C. Siregar, U. W. M. Liana, and A. Rachman, “Studi Perencanaan Pengembangan Jaringan Perpipaan Distribusi Air Minum di Kecamatan Melak, Kabupaten Kutai Barat,” *Rang Teknik Journal*, vol. 6, no. 2, pp. 63–75, 2023.

[8] N. Haryati, “Analisis Kebutuhan Dan Ketersediaan Air Bersih Pdam Kota Baubau Di Kelurahan Lipu, Kecamatan Betoambari. ,” *Jurnal MAHANDIA*, vol. 8, no. 2, pp. 32–45, 2024

[9] H. Irsyam, A. M. Kandari, H. Syaf, L. O. Sabaruddin, and L. Baco, “Analisis Pengembangan Intake Wanggu Terhadap Penyediaan Air Bersih di Kecamatan Wua-Wua,” *Jurnal Perencanaan Wilayah*, vol. 8, no. 2, pp. 116–127, 2023.

[10] R. M. K. Yanti and A. N. Dewanti, “Proyeksi Kebutuhan Air Bersih Jangka Pendek dan Menengah Kecamatan Penajam Kabupaten Penajam Paser Utara,” *Konstruksia*, vol. 13, no. 2, pp. 113–124, 2022.