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Analysis of the Availability and Need of Clean Water with the Development of Smart Tank Technology in Cibinong Urban Area

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Abstract
Water is a basic human need whose existence is very much needed and is used to support the daily needs of life. Clean water is now a very serious problem in the city of Cibinong. The need for clean water every year has increased while the availability of clean water is increasingly limited, due to the narrower of the catchment area, the many developments that do not pay attention to the balance of nature, the exploitation of raw water sources that do not pay attention to the preservation of water sources, and population growth, and the rapid flow of urbanization. In order to avoid water shortages, it is necessary to maintain and preserve existing water sources, efficiency in water use and the search for alternative new sources. In this study, it is predicted the need for clean water for the service area of PDAM Tirta Kahuripan Cibinong in 2019 and analyze the availability of clean water until 2038 by using secondary data references from PDAM Tirta Kahiripan, whereas in its calculations using the Geometric and Arithmetic methods.
The new city of Cibinong has a water source that comes from a communal clean water source provided by the Regional Drinking Water Company (PDAM). (Bogor Regency Regulation No. 17. 2011). According to data from PDAM Tirta Kahuripan, the new PDAM can only serve about 26.46% of the population of Bogor Regency. Kota Baru Cibinong has only reached 17.36% of service coverage, and even then with limited quality, quantity and continuity. While the rest, residents of the Cibinong urban area meet their clean water needs independently with a non-piping system by utilizing groundwater sources through shallow wells. The analysis shows that the water demand in the Tirta Kahuripan Cibinong PDAM service area for 2019 is 740,206 lt / sec, while the availability of water is 643.36 lt / sec, so that the water shortage is 96,846 lt / sec. The results of the analysis in 2038 are predicted to occur due to a shortage of 865,583 lt / sec. So that the infiltration well water source can be utilized sustainably to meet the needs of clean water in the service area, it is necessary to optimize the development of water supply infrastructure in the form of rainwater harvesting tubs called Smart Tanks. Smart Tanks can be implemented in communal areas to meet the clean water needs of the Cibinong urban community.
Keywords*: Water demand, Water availability, Smart Tank Development Plan.*

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I. Introduction

Clean water supply system is one of the main priorities in terms of planning the development of an urban settlement (Catanese & Snyder, 1996). The need for clean water in an area is determined based on the level of regional development, including the number of users, the level of service in the area, and service to existing regional facilities. All activities and activities that occur in an area become one of the parameters of the development of an area.

One of the main parameters that plays a role is the development of the population so that the need for drinking water also increases. To get proper clean water, treatment is needed before consuming it. In the design of a drinking water supply system requires sufficient data regarding the amount of volume and flow of water to be flowed as well as its relationship with the population and planning period.

Scarcity of clean water is a matter where the conditions for not meeting the needs of clean water in accordance with existing requirements (Jauad El Kharraz, 2012). The amount of water demand that exceeds its

supply capacity and the unfulfillment of clean water service requirements causes water scarcity, so it tends to have a negative impact.

In addition to the above factors, it is also necessary to take into account the factor of water loss which causes water scarcity during the treatment process at the installation and during the process of water distribution to consumers.

In order to overcome the problem of scarcity of clean water in the community, there are a number of basic approaches that must be taken to solve them, one that focuses on ecological resilience and engineering resilience (Holling, 1996; Butler D, 2014). Ecological resilience is a resilience that focuses on managing the existence of ecological system functions (system integrity). While engineering resilience emphasizes ensuring the efficiency of the system and avoiding errors in the water supply system (system performance).

Another factor that needs to be considered in calculating water requirements is the greatest fluctuation in water usage at a certain time. Fluctuations in water use consist of:

1. Maximum day usage, i.e. the highest usage for 1 day in a 1 year period. Calculation of maximum water needs is the average requirement multiplied by the maximum day factor.
2. Maximum hours usage, i.e. the highest usage for 1 hour in 1 day. This is caused by the existence of concurrent usage.

The purpose of this study was to determine the availability and demand for water in the urban residential area of Cibinong.

II. Research methodology

Place and time of research

In this study, researchers calculated the amount of water needed and water availability in the City of Cibinong based on data from PDAM Tirta Kahuripan, Bogor Regency. When the study was conducted in early 2017 up to 20 years to come. The population data used is the total population from 2010 to 2018 (BPS Bogor in 2018).

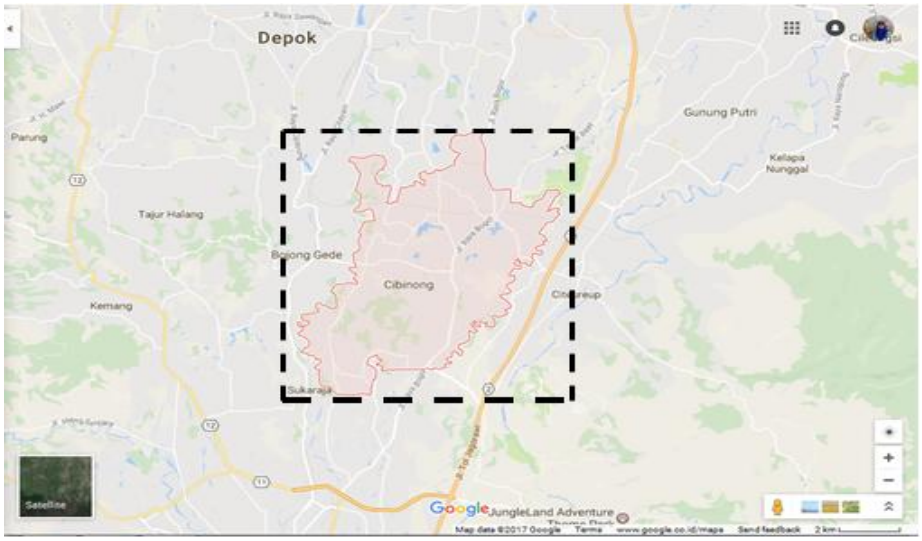

Figure 2.1 Map of the study area
Source: (BPS Bogor in 2013)

This study uses 2 methods, namely qualitative and quantitative analysis. Qualitative analysis is used to inventory the potential availability of raw water available. Whereas quantitative analysis is used to predict population and raw water needs until 2038 for Cibinong sub-district. The main ideas obtained from the literature in accordance with the study, developed in harmony with the development, water sources, socio-economic conditions, culture and the local environment.

Overall this research activity can be broken down into a flowchart as shown in Figure 3.1. the following:

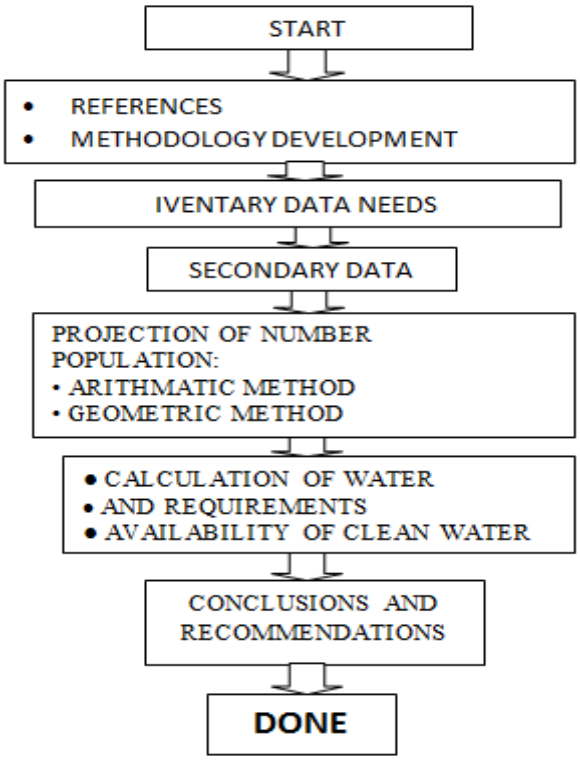

Figure 2.2 Research Flow

Data Types and Sources

In general, the type of data in a study comes from secondary data. In this study the data used in the form of secondary data in the form of population data from the Statistics Agency (BPS) Cibinong Urban and water demand data from PDAM Tirta Kahuripan, Bogor Regency.

Secondary Data

Secondary data is also called available data which is data obtained or collected from existing sources. The data is usually obtained from the library or from previous research reports / documents, identifying and processing data from various data sources by making records or quoting from data sources that have been previously processed by the relevant agencies (Supardi, 2013).

Secondary data in this study are data:

1. Total Population in the Cibinong Urban area in 2009 - 2018
2. Map of the water service area in Cibinong Urban
3. Water Treatment Plant Installation Location
4. Clean water distribution area from PDAM
5. Domestic and Non-Domestic water demand
6. Availability of clean water

Projection of Population:

a. Arithmetic Method

Pn Po + Ka (Mr - To)

where: Pn = total population in the nth year;

Po = population in the base year;

Tn = nth year;

To = base year;

Ka = arithmetic constant;

P1 = number of residents known in year I;

P2 = total population known in the last year;

T1 = known year I;

T2 = known year II.

b. Geometric Method

Pn = P (1+ r) n
where: Pn = total population in the nth year;
Po = population in the base year;
r = population growth rate;
n = number of intervals

III. Results

Population Data

Data on population in this study were obtained from the Central Statistics Agency (BPS) in the Cibinong Urban area from 2009 to 2018 (BPS Cibinong, 2019).

Table 3.1 Percentage Growth Rate of Population in 2009-2018

Year	Total Population	Population Growth	
		Souls	Percent (%)
2009	273.680		
2010	287,581	13.901	4.83
2011	290,333	2.752	0,95
2012	300.386	10.053	3,23
2013	310,415	10.029	3,34
2014	318,043	7.628	2,40
2015	372.903	54.860	14,71
2016	412,256	39.353	9,55
2017	427.014	14.758	3,46
2018	447.052	20.038	4,48
Total		173.372	42,12

Source: BPS Cibinong Subdistrict in Figures 2019

Customer Data and Amount of Water Needs

Table 3.2. : Data on Water Needs in Cibinong

No	Costumer's Name	Amount of Water Needs L/Sec
1	Housing	372,543
2	Public Hydrant	41,394
3	Education	9,045
4	The mosque	7,049
5	Mushollah	8,681
6	Office space	9,588
7	Department store	0,589
8	Public health center	0,278
9	Hospital	0,014
10	Market	18,627
11	Hotel	0,003
12	Army/Police complex	0,003
13	Industry	175,546
	Total	643,36

Source: (PDAM Tirta Kahuripan Urban Cibinong in 2018)

Data The ability of processing discharge or water production capacity from PDAM Tirta Kahuripan Urban Cibinong from 2014 to 2018 is 643.36 l / sec

Population Projection Estimated

Population growth is used to calculate the amount of water demand in the future. In this study, the projected population growth for the next 20 years in the Cibinong Urban area is calculated based on the total population data for 2009 - 2018 (BPS Bogor District, 2019) as in table 3.1. In table 4.1. calculated percentage of population growth in the City of Cibinong based on table 3.1.

Analysis of Population Growth

Table 5.2 provides population data for Cibinong Subdistrict from 2018-2038. From these data, the annual growth rate is calculated using the Geometric and Arithmetic method. The growth ratio is then averaged to be able to project population growth in the next 10 years.

Table 3.3 Data on Population Growth from 2018 – 2038

No	Year	Total (Souls)	Growth (Arithmatic) (Souls)	Growth (Geometrik) (%)
1	2009	273680		
			13.901	+ 4.83 %
2	2010	287581		
			2.752	0,95%
3	2011	290333		
			10.053	3,23%
4	2012	300386		
			10.029	3,34%
5	2013	310415		
			7.628	2,40%
6	2014	318043		
			54.860	14,71%
7	2015	372903		
			39.353	9,55%
8	2016	412256		
			14.758	3,46%
9	2017	427014		
			20.038	4,48%
10	2018	447052		
	Total	173372	19.264	42,12%
	Average		**19.263,56**	**4,68%**

Source: Analysis results

Population Projection of Arithmetic and Geometric Methods

The projection of the population using the Arithmetic method for the next 20 years in Cibinong Urban is the following equation:

By departing from population data in 2018, recalculate the annual population from 2009 to 2018 using the arithmatic and geometric methods.

Pn = Po + Ka (Tn - To)

Where : Tn = nth year according to plan, that is 2038 (planned age)

Po = population in the base year (P2014), amounting to 447,052 inhabitants

Ka = Arithmetic constant value:

Ka = (Pa-P1) / (T2-T1) Ka = ((P2018-P2009)) / (2018-2009) Ka = ((447,052-273,680)) / 9 = 19,263,55 people / year

Ka = P (2018) = 447,052
P (2009) = 447,052-19,263.55 (2018-2009) = 273,680
P (2010) = 447,052-19.26355, (2018-2010) = 287,581
P (2018) = 447,052-19,263.55 (2018-2018) = 447,052

The projected population growth in Cibinong Urban with Geometric methods for the next 20 years is the equation: $Pn = Po (1 + r)^{n}$
Where :
Pn = Total population of the nth year Po = initial population = 447,052 inhabitants (2009 - 2018) r = percentage of population growth (table 4.1)
Looking for population growth:
n = time period (n = 20 years so that:
Pn = Po (1 + r) n
$P (2018) = P (2009) (1 + r)^{20}$
$447,052 = 278,680 (1 + r)^{20}$
1.0239 = 1+ r

Table 3.4 Calculation of Population Projections for 2018 to 2038

No	Year	n	Arithmatic Method Pn= 447052 + 19.263,555.n (Souls)	Geometric Method Pn=447052(1+ 0, 0468)^{n} (Souls)	Projection Average (Souls)
1	2018	0	447052	447.052	447052
2	2019	1	466316	467.974	467145
3	2020	2	485579	489.875	487727
4	2021	3	504843	512.801	508822
5	2022	4	524106	536.800	530453
6	2023	5	543370	561.923	552646
7	2024	6	562633	588.221	575427
8	2025	7	581897	615.749	598823
9	2026	8	601160	644.567	622863
10	2027	9	620424	674.732	647578
11	2028	10	639688	706.310	672999
12	2029	11	658951	739.365	699158
13	2030	12	678215	773.967	726091
14	2031	13	697478	810.189	753834
15	2032	14	716742	848.106	782424
16	2033	15	736005	887.797	811901
17	2034	16	755269	929.346	842307
18	2035	17	774532	972.839	873686
19	2036	18	793796	1.018.368	906082
20	2037	19	813060	1.066.028	939544
21	2038	20	832323	1.115.918	974121

Population Projections for 2018 to 2038
Source: Analysis results

Figure 3.1Population Projection Graph of Cibinong District

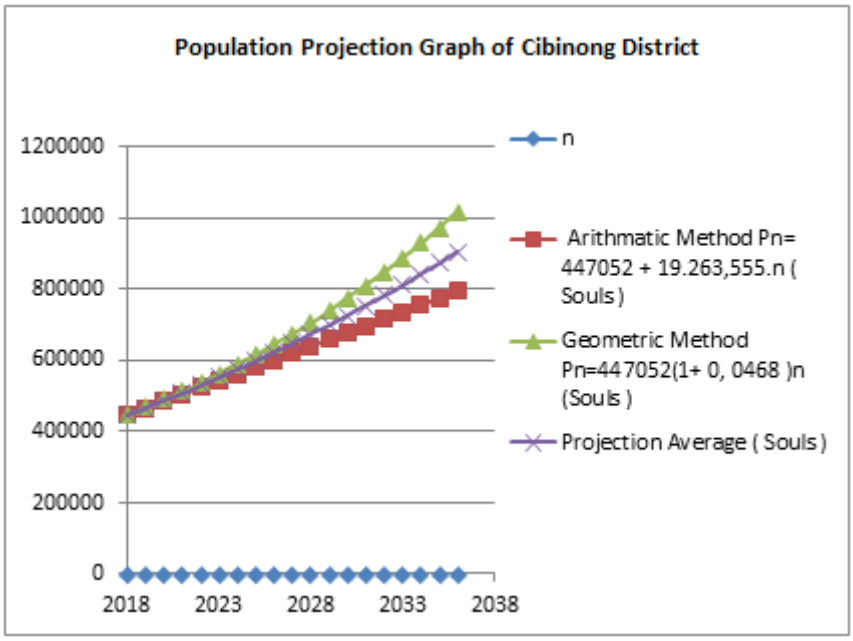

Figure 3.1. Population Projection Chart for Cibinong District in 2018 to 2038

From the analysis above, the population of Cibinong Subdistrict in 2038 was 974121 people (projected 20 years), so according to Table 5.1, Cibinong Subdistrict is included in the medium city category with a population ranging from 100,000 - 500,000.

Analysis of Clean Water Needs

Estimated amount of future clean water needs is calculated based on water needs in the domestic and non-domestic sectors. The need for clean water in the domestic sector includes water needs for house connections (SR) and public hydrant (HU) or public tap (KU) water needs. Whereas the water requirement for HU or KU is calculated based on the need for public facilities and facilities in related installations, for example for hospitals, industries, schools, and others.

Home Connection (SR)

The total domestic water needs for house connections (SR) in 2014 are as follows:
Number of people served = Total population x service level
= 447,052 x 80%
= 357,642 people
The amount of water needed = the number of people SR x the number of uses
= 357,642 people x 90 lt / org / day: 1000
= 32,188 m3 / day
= 0.672 lt / sec ≈ 0.373 liter / sec
Domestic water demand for the upcoming SR 20 connection is as in the following table:

Table 3.5 Domestic Sector Water Needs for Home Connections (SR) in 2038

No	Year	Total Population (Souls)	Tingkat Pelayanan 80% (Souls)	Water Consumtion Average (L/Soul/H)	Total Usage (Lt/Hari)	Total Water Needs (L/S)
[a]	[b]	[c]	[d]	[f]	[g]	[h]
1	2018	447052	357642	90	32188	372,543
2	2019	467145	373716	90	42043	486,609
3	2020	487727	390182	90	43895	508,049
4	2021	508822	407058	90	45794	530,023
5	2022	530453	424362	90	47741	552,555
6	2023	552646	442117	90	49738	575,673
7	2024	575427	460342	90	51788	599,403
8	2025	598823	479058	90	53894	623,774
9	2026	622863	498290	90	56058	648,816
10	2027	647578	518062	90	58282	674,560
11	2028	672999	538399	90	60570	701,041
12	2029	699158	559326	90	62924	728,290
13	2030	726091	580873	90	65348	756,345
14	2031	753834	603067	90	67845	785,244
15	2032	782424	625939	90	70418	815,025
16	2033	811901	649521	90	73071	845,730
17	2034	842307	673846	90	75808	877,403
18	2035	873686	698949	90	78632	910,090
19	2036	906082	724866	90	81547	943,835
20	2037	939544	751635	90	84559	978,692
21	2038	974121	779297	90	87671	1.014,709

Source: Calculation Result

Note: [a] = Number
[b] = Projection year (planning year)
[c] = Result of calculating population projection (table 5.3)
[d] = Table 5.1 no.12 column 5 (small town)
[e] = [c] x [d] / 1000
[f] = [e] / 86.4

Note: 86.4 = (24 hours x 60 minutes x 60 seconds) / 1,000 liters
Prediction of water needs in the domestic sector until the year 2038 or 20 years to come is 1,014,709 liters / second, as in table 4.5.

Domestic Water Needs from Public Hydrants (HU / KU)

Total domestic water needs for public hydrants (HU) in 2019 are as follows:
Number of people served = Total population x service level
= 447,052 x 20%
= 89,410 inhabitants ≈ 96,833 inhabitants
The amount of water needed = the number of HU people x the number of uses
= 89,410 people x 40 lt / org / day: 1000
= 3,576 ≈ 3,576 m3 / day
= 0.045 lt / sec

Table 3.6 Total Domestic Sector Water Needs

No	Year	Clean Water Needs		Total Needs Domestic Water
		SR	HU/KU	
		L/sec	L/sec	L/sec
[a]	[b]	[]c	[d]	[e]
1	2018	41,394	41,394	82,787
2	2019	216,271	216,271	432,542
3	2020	225,800	225,800	451,599
4	2021	235,566	235,566	471,131
5	2022	245,580	245,580	491,160
6	2023	255,855	255,855	511,709
7	2024	266,401	266,401	532,803
8	2025	277,233	277,233	554,466
9	2026	288,363	288,363	576,725
10	2027	299,805	299,805	599,609
11	2028	311,574	311,574	623,147
12	2029	323,684	323,684	647,369
13	2030	336,153	336,153	672,306
14	2031	348,997	348,997	697,994
15	2032	362,233	362,233	724,467
16	2033	375,880	375,880	751,760
17	2034	389,957	389,957	779,914
18	2035	404,484	404,484	808,969
19	2036	419,482	419,482	838,965
20	2037	434,974	434,974	869,948
21	2038	450,982	450,982	901,964

Source: Calculation Result

From table 5.9 it is known that the total water demand in the Domestic sector in 2019 is 432,542 liters / second, and in 2038 it is 901,964 liters / second. This shows an increase in water demand in the planned year due to the predicted increase in population in 2038.

Non-Domestic Sector Water Needs

Based on the Standards of the Director General of Human Settlements of the Public Works Office in 1996 for the Metropolitan city sector category, the Non-Domestic water demand in the Cibinong Regency and Urban areas is calculated based on the following matters:

1. Office facilities = 10 liters / employee / day with projections 500 employees added per year
2. Educational facilities = 10 liters / student / day with a projected increase 500 students per year at all levels
3. Means of Lodging = 150 liters / bed / day with a projected increase 100 beds per year for all lodging classes
4. Health Facilities = 2,000 liters / unit / day with projections 20 units added per year
5. Market = 12,000 liters / hectare / day with projections an increase of 20 hectares per year of all types market
6. Means of worship = 3,000 liters / unit / day with a projected increase 10 units per year for all types of places of worship
7. Public Facilities = 12,000 liters / hectare / day with projections an increase of 20 hectares per year of all types public facilities

The analysis of the non-domestic sector is carried out by holding on to the analysis of the latest growth data of the existing socio-economic facilities in the planning area. Non-domestic water needs according to the planning criteria at the Public Works Agency can be seen in Table 2.3 to Table 2.5 below:

Table 3.7 Non-Domestic Water Needs for Cities Category I, II, III, IV

SECTOR	VALUE	UNIT
School	10	liter / student / day
Hospital	200	liter / bed / day
Public health center	2000	liter / unit / day
The mosque	3000	liter / unit / day
Office	10	liters / employee / day
Market	12000	liter / hectare / day
Hotel	150	liter / bed / day
Restaurant	100	liters / seating / day
Military Complex	60	liter / person / day
Industrial area	0,2 - 0,8	liter / second / hectare
Tourism area	0,1 - 0,3	liter / second / hectare

Source: Planning Criteria DG Cipta Karya Department of Public Works, 1996

Table 3.8 Non-Domestic Water Needs for Category V (Village)

SECTOR	VALUE	UNIT
School	5	liter / student / day
Hospital	200	liter / bed / day
Public health center	1200	liter / unit / day
The mosque	3000	liter / unit / day
Mosque	2000	liter / unit / day
Market	12000	liter / hectare / day
Commercial / Industrial	10	liters / day

Source: Planning Criteria DG Cipta Karya Department of Public Works, 1996

Education facility

The number of clean water needs for educational facilities calculated in this study are students in the Cibinong Urban area starting from the level of Elementary Schools, Madrasahs, Junior High Schools, Madrasah Tsanawiyah, High Schools / Vocational Schools and Madrasah Aliyah recorded in the Central Board Statistics Bogor in 2019. From the regulation of the Directorate General of Human Settlements, the factor that is taken into account is the number of students who need 10 liters of water / person / day. The amount of water demand in the Non-Domestic sector for educational facilities in 2018 is as follows:
Projection of the number of students = increasing 500 people per year per level
Total water needs = number of people served x number of uses
= 78146 inhabitants x 10 lt / org / day: 1000
= 781.46 m3 / day
= 9,045 lt / sec

Health facility

The number of clean water needs for health facilities calculated in this study is the number of health facility units (puskesmas) in the Cibinong Urban area which were recorded in the 2013 Bogor Statistics Agency. The amount of water needed in the Non-Domestic sector for health facilities in 2014 is as follows:
Projected number of units = increase by 1 unit per 4 years
Total water needs = number of units served x number of uses = 12 units x 2000 lt / unit / day: 1000 = 24 m3 / day = 0.278 lt / sec.

Hospital Facilities

The number of clean water needs for health facilities calculated in this study is the number of hospital facility units in the Cibinong Urban area which were recorded in the 2013 Bogor Statistics Agency. The amount of water needed in the Non-Domestic sector for hospital facilities in 2014 is as follows:
Projected number of units = constant
Total water needs = number of units served x number of uses
= 6 units x 2000 lt / unit / day: 1000
= 12 m3 / day = 0.014 lt / sec.

Hotel facility

The development of health facilities until 2016 is assumed to be constant, meaning that there is no increase for this type of facility, so the amount of water needed for this facility remains from 2006 - 2016.

The number of clean water requirements for lodging facilities calculated in this study is the number of bed units in lodging such as starred and non-starred hotels in the Cibinong Urban area which were recorded in the Bogor Statistics Agency in 2018. The amount of water demand in the Non-Domestic sector for lodging facilities in 2014 is as follows:

Projected number of units = constant 2 units
Number of water needs = number of beds served x number of uses
= 2 units x 150 lt / bed / day: 1000
= 3 m3 / day = 0.003 lt / sec

Military / Police Complex

Complex Facilities The development of Military / Polres Complex facilities until 2016 is assumed to be constant, meaning that there is no increase for this type of facility, so the amount of water needed for this facility remains from 2006 - 2016. The amount of water demand in the Non-Domestic sector for military complex facilities in 2014 is as follows:

Projected number of units = constant 4 units Number of water needs
= number of beds served x number of uses
= 4 units x 60 lt / bed / day: 1000
= 0.24 m3 / day
= 0.003 lt / sec

Means of Worship

The number of clean water requirements for worship facilities calculated in this study is the number of worship units ranging from mosques, prayer rooms, churches, temples, temples, and temples in the Cibinong Urban area which were recorded in the 2013 Central Statistics Agency.

The amount of water needed in the Non-Domestic sector for worship facilities in 2014 is as follows:

Worship facilities are used by the community as a means of performing worship so that the growth in the number of worship is assumed to be the same as the population growth rate of Gunem District. In the regulations set by the Directorate General of Human Settlements, Dep. PU obtained clean water needs for the mosque at 3000 liters / unit / day and Mushola at 2000 liters / unit / day.

The projected number of mosques is assumed to increase 2 units every 5 years for the mosque, and 2 units for the mosque every 2 years. Calculation of water needs for mosques and prayer rooms can be seen in Table 5.18 as follows:

Projected number of units = increased by 2 units per 5 years
Total water needs = number of units served x number of usage
= 203 units x 3000 lt / unit / day: 1000
= 609 m3 / day
= 7.049 lt / sec

The projected number of mosques is assumed to increase by 2 units every month. Calculation of water needs for mosques and prayer rooms can be seen in Table 5.19 as follows:

Projected number of units = 2 units per 2 years
Total water needs = number of units served x number of uses
= 375 units x 2000 lt / unit / day: 1000
= 750 m3 / day
= 8,681 lt / sec

Market Facilities

There are also market facilities that cater to basic daily needs. In the market requires the availability of clean water. Analysis of clean water needs for market facilities can be seen in table 5.10. The amount of clean water needs for the market calculated in this study is the size of the market area in the Cibinong Urban area which was recorded in the Bogor Statistics Agency in 2011.

The amount of water demand in the Non-Domestic sector for Market facilities in 2014 is as follows:

Projected total area = 10 hectares per year
Total water needs (market) = market area served x number of uses
= 13,4116 ha x 12,000 lt / ha / day: 1000
= 160.94 m3 / day

= 1,863 ltr / sec ≈ 1,863 ltr / sec

Office Facilities

The number of clean water needs for public facilities calculated in this study is the number of employees in office buildings of all sectors located in the Cibinong Urban area which were recorded in the Bogor Statistics Agency in 2018.

The amount of water needed in the Non-Domestic sector for office facilities in 2014 is as follows:

Projected number of employees = 20 employees per year
Total water needs = number of employees served x total usage
= 82,840 x 10 lt / person / day: 1000
= 828.4 m3 / day
= 9.588 lt / sec

Predictions of water demand for the non-domestic sector until 2038 are shown in the following table:

Table 3.9 Total Predictions of Water Needs for Domestic and Non-Domestic Sectors from 2018 to 2038

No	Year	SR	HU	Education	Workship		Office	Department Store	Public Health Centre	Hospital	Market	Hotel	Amry/Police	Total
		(L/sec)	(L/sec)	(L/sec)	Mosque(L/sec)	The Moaque(L/sec)	(L/sec)	(L/sec)	(L/sec)	(L/sec)	(L/sec)	(L/sec)	(L/sec)	(L/sec)
1	2018	372,543	41,394	9,045	7,049	8,681	9,588	0,589	0,278	0,014	1,863	0,003	0,003	451
2	2019	486,609	216,271	9,173	7,049	8,681	9,590	0,589	0,278	0,014	1,946	0,003	0,003	740
3	2020	508,049	225,800	9,303	7,049	8,727	9,593	0,590	0,278	0,014	2,032	0,003	0,003	771
4	2021	530,023	235,566	9,435	7,049	8,727	9,595	0,590	0,278	0,014	2,120	0,003	0,003	803
5	2022	552,555	245,580	9,569	7,049	8,773	9,597	0,591	0,301	0,014	2,210	0,003	0,003	836
6	2023	575,673	255,855	9,705	7,118	8,773	9,600	0,591	0,301	0,014	2,303	0,003	0,003	870
7	2024	599,403	266,401	9,842	7,118	8,819	9,602	0,591	0,301	0,014	2,398	0,003	0,003	904
8	2025	623,774	277,233	9,982	7,118	8,819	9,604	0,592	0,301	0,014	2,495	0,003	0,003	940
9	2026	648,816	288,363	10,123	7,118	8,866	9,606	0,592	0,324	0,014	2,595	0,003	0,003	976
10	2027	674,560	299,805	10,267	7,118	8,866	9,609	0,593	0,324	0,014	2,698	0,003	0,003	1014
11	2028	701,041	311,574	10,413	7,188	8,912	9,611	0,593	0,324	0,014	2,804	0,003	0,003	1052
12	2029	728,290	323,684	10,560	7,188	8,912	9,613	0,594	0,324	0,014	2,913	0,003	0,003	1092
13	2030	756,345	336,153	10,710	7,188	8,958	9,616	0,594	0,347	0,014	3,025	0,003	0,003	1133
14	2031	785,244	348,997	10,862	7,188	8,958	9,618	0,595	0,347	0,014	3,141	0,003	0,003	1175
15	2032	815,025	362,233	11,016	7,188	9,005	9,620	0,595	0,347	0,014	3,260	0,003	0,003	1218
16	2033	845,730	375,880	11,172	7,257	9,005	9,623	0,596	0,347	0,014	3,383	0,003	0,003	1263
17	2034	877,403	389,957	11,331	7,257	9,051	9,625	0,596	0,370	0,014	3,510	0,003	0,003	1309
18	2035	910,090	404,484	11,491	7,257	9,051	9,627	0,597	0,370	0,014	3,640	0,003	0,003	1357
19	2036	943,835	419,482	11,654	7,257	9,097	9,630	0,597	0,370	0,014	3,775	0,003	0,003	1406
20	2037	978,692	434,974	11,820	7,257	9,097	9,632	0,597	0,370	0,014	3,915	0,003	0,003	1456
21	2038	1014,709	450,982	11,987	7,326	9,144	9,634	0,598	0,394	0,014	4,059	0,003	0,093	1509

Source: Calculation Result

Total Domestic and Non-Domestic Sector Water Needs

The total water demand in the domestic and non-domestic sectors until 2038 is as the following table:

Table 3.10 Total Domestic and Non-Domestic Sector Water Needs

No	Year	Sector		Total
		Domestic	Nondomestic	Water Needs
		L/sec	L/sec	L/sec
1	2018	413,937	37,111	451,048
2	2019	702,880	37,326	740,206
3	2020	733,848	37,591	771,439
4	2021	765,589	37,813	803,402
5	2022	798,135	38,110	836,245
6	2023	831,528	38,410	869,938
7	2024	865,805	38,692	904,496
8	2025	901,007	38,931	939,938
9	2026	937,178	39,245	976,424
10	2027	974,365	39,495	1013,860
11	2028	1012,614	39,865	1052,479
12	2029	1051,974	40,124	1092,098
13	2030	1092,498	40,459	1132,957
14	2031	1134,241	40,729	1174,970
15	2032	1177,258	41,051	1218,309
16	2033	1221,610	41,402	1263,013
17	2034	1267,360	41,760	1309,120
18	2035	1314,574	42,054	1356,628
19	2036	1363,318	42,401	1405,719
20	2037	1413,666	42,708	1456,374
21	2038	1465,691	43,252	1508,943

Source: Calculation Result

From the results of the calculation of table 4.10. the amount of water demand in Cibinong Urban in the domestic and non-domestic sectors in 2019 was 980.24 liters / second and in 2038 it was 1,712.79 liters / second.

Prediction of Water Needs in the Planned Year

The prediction of water demand is calculated based on the availability of water supply (Water Management Installation) of PDAM Tirta Kahuripan in 2014 against the prediction of the population and the prediction of Cibinong Urban water needs in the domestic and non-domestic sectors as in table 4.10 above.

By using the linear regression equation Y = a + b * X -> where x is the projection year, the prediction of water discharge until 2038 is as follows:

The capacity of the source of raw water produced by PDAM Tirta Kahuripan is 1,030 liters / second (Data section 3.4.3). So that the addition of raw water debit in the next 20 years in the non-domestic and domestic sectors is the future discharge capacity reduced by the current production capacity, as in the following table:

Table 3.11 Results of Projection of the Needs, Availability and Shortage of Tirta Kahuripan WTP Water Pump Discharge

No	Year	Water Discharge L/sec	Total Needs L/sec	Total Lack Of Water L/sec
1	2018	643,360	451,048	-192,312
2	2019	643,360	740,206	96,846
3	2020	643,360	771,439	128,079
4	2021	643,360	803,402	160,042
5	2022	643,360	836,245	192,885
6	2023	643,360	869,938	226,578
7	2024	643,360	904,496	261,136
8	2025	643,360	939,938	296,578
9	2026	643,360	976,424	333,064
10	2027	643,360	1013,860	370,500
11	2028	643,360	1052,479	409,119
12	2029	643,360	1092,098	448,738
13	2030	643,360	1132,957	489,597
14	2031	643,360	1174,970	531,610
15	2032	643,360	1218,309	574,949
16	2033	643,360	1263,013	619,653
17	2034	643,360	1309,120	665,760
18	2035	643,360	1356,628	713,268
19	2036	643,360	1405,719	762,359
20	2037	643,360	1456,374	813,014
21	2038	643,360	1508,943	865,583

Source: Calculation Result

The table above shows that the shortage of water in 2038 is estimated at 865,583 liters / second.

The shortage of water needs in the planned year was met by the addition of a water treatment installation (IPA) development plan in PDAM Tirta Kahuripan, Bogor Regency.

Regional Water Treatment Plant Development Plan (IPA)

The planned area development plan is planned by dividing the number of plan years into five (5) years, as in the table below:

Table 3.12 IPA plan based on Water Supply Shortages

Year	X	Total Water Needs (l/sec)	Total Lack Of Water (l/sec)
2019	2	740,206	96,846
2024	7	904,496	261,136
2029	12	1092,098	448,738
2034	17	1309,120	665,760
2038	21	1508,943	865,583

Source: Calculation Result

Table 3.13 Smart Tank plans based on Water Supply Shortages

Year	X	Total Water Needs (l/sec)	Total Lack Of Water (l/sec)	Plans IPA (l/sec)	Smart Tank 5x10x2 M3(Unit)
2019	2	740,206	96,846	1,157	84
2024	7	904,496	261,136	1,157	226
2029	12	1092,098	448,738	1,157	388
2034	17	1309,120	665,760	1,157	575
2038	21	1508,943	865,583	1,157	748

Source: Calculation Result

Table 3.14 Water Needs and Availability

No.	Year	Water Needs (l/sec)	Water Availability (l/sec)
1	2019	740,206	643,360
2	2024	904,496	643,360
3	2029	1092,098	643,360
4	2034	1309,120	643,360
5	2038	1508,943	643,360

Source: Calculation Result

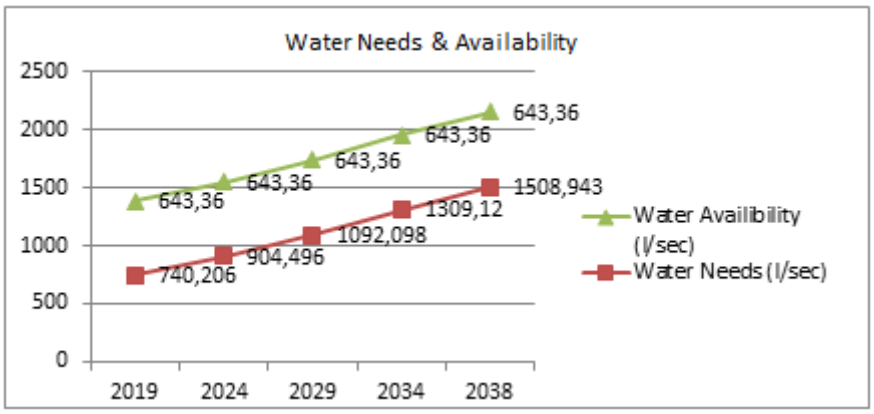

Figure 3.2 Water Needs & Availability
Source: Calculation Result

Table 3.15 Water Shortages

No.	Year	Water Shortages (l/sec)
1	2019	96,846
2	2024	261,136
3	2029	448,738
4	2034	665,760
5	2038	865,583

Source: Calculation Result

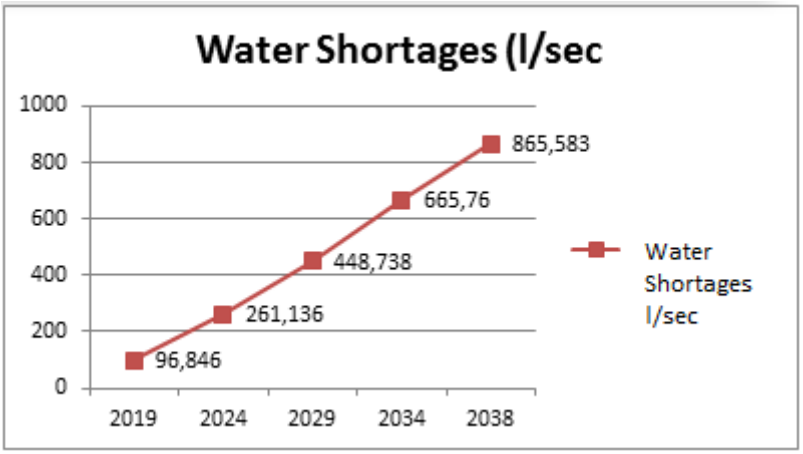

Figure 3.3 Water Shorttages
Source: Calculation Result

Table 3.16 Natural Science Needs, Weaknesses, and Development Plans

No.	Year	Water Needs (l/sec)	Water Availability (l/sec)	Water Shortages (l/sec)	Plans Smart Tank (Unit)
1	2019	740,206	643,360	96,846	84
2	2024	904,496	643,360	261,136	226
3	2029	1092,098	643,360	448,738	388
4	2034	1309,120	643,360	665,760	575
5	2038	1508,943	643,360	865,583	748

Source: Calculation Result

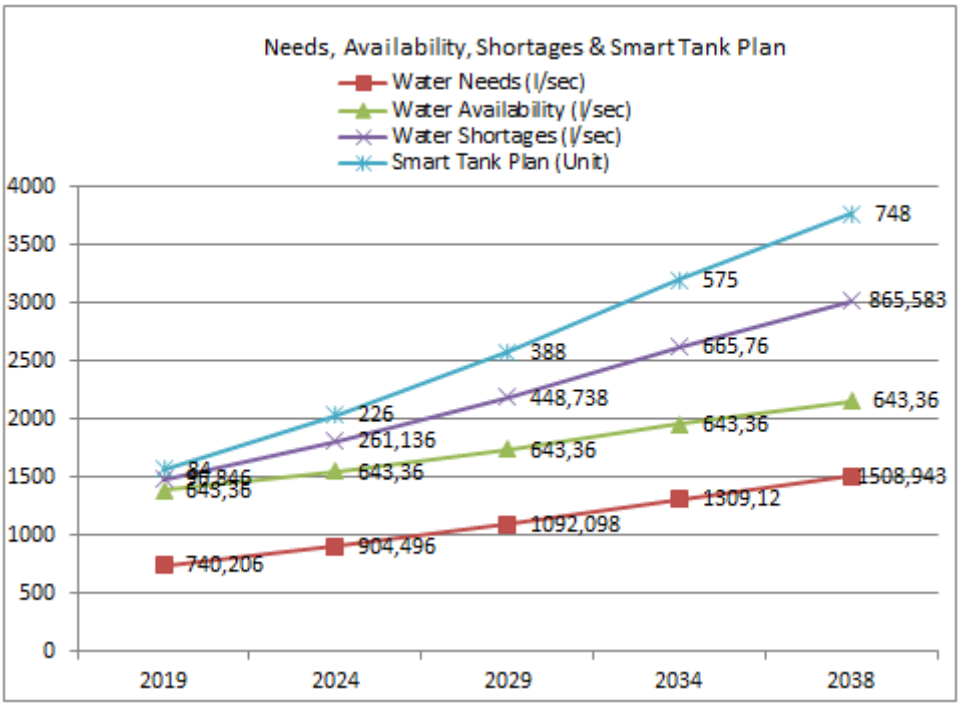

Figure 3.4 Figure of Water Needs, Water Lack, and Development Smart Tank Plan
Source: Calculation Result

IV. Conclusions

Conclusions

1. The need for clean water in the Cibinong Urban area for the next 20 years is calculated based on projected population growth using an average of the arithmetic and Geometric methods with a predicted population of 2018 of 447,052 people, and a predicted population of 2038 by 2038 974,121 inhabitants. The current availability of water discharge of 643,360 liters / second is only able to meet the water needs of the population of Urban Cibinong until 2018.
2. The availability of water in the planning year, which is 20 years to come, is 643,360 liters / second, and to meet the need for clean water of 1508,943 liters / second in 2038, it is necessary to supply raw water that is flowed from alternative sources, namely the fulfillment of Sulai infrastructure. clean water (water harvesting).
3. Clean water needs in the Cibinong Urban area are calculated based on water needs for the Domestic and Non-Domestic sectors with a predicted population growth for the next 20 years. The calculation results show that the demand for water at the beginning of the planned year in 2019 was 757,724 liters / second and the water demand for 20 years or 2038 was 1508,943 liters / second. The shortage of water pump discharges starting from the planning year 2019 of 96.846 liters / second to the planning year of 2038 of 1508,943 liters / second requires the development of a Smart Tank water treatment plant (IPA).

The Tirta Kahuripan Urban Cibinong raw water supply plan is planned by dividing the number of planned years into five (5) years. In 2019 96,846 liters / second of raw water supply is needed which is divided into twelve villages, each with eight units of 84 units of water tanks with a volume of 5mx10mx2m. In 2024, raw water supply of 261,136 liters / second is needed which is divided into twelve villages, each with eight units of 226 tanks with a volume of 5mx10mx2m. In 2029, raw water supply of 448,738 liters / second is needed which is divided into twelve villages, each with eight units of 388 units with a volume of 5mx10mx2m. In 2034, raw water supply from an alternative source is needed, namely the fulfillment of 665,760 liters / second of clean water (water harvest) infrastructure divided into twelve villages, each with eight units of 575 water reservoirs with a volume of 5mx10mx2m. In 2038, a supply of 865,583 liters / second of raw water is needed which is divided into twelve villages, each with eight units of 748 units with a volume of 5mx10mx2m.

Suggestions

1. This research is expected to be used as input material for the next research by developing several methods in analyzing water needs and analyzing population projections.
2. There needs to be improvement and optimization of existing treatment installation units in the area of PDAM Tirta Kahuripan in the City of Cibinong in order to meet the clean water needs of the community in the Cibinong Urban area both now and in the future.
3. Improving the quality of water supply services and the availability of water treatment plants should be a concern of the management of drinking water services in each region to avoid water shortages.

The need to increase water treatment units and raw water supply given the future, because the population continues to increase every year.

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