

System Planning (Clean Water and Wastewater Installation) at the Pontianak State Polytechnic Student Dormitory

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To cite this article:

Ayuni, T. D., Fikriyah, N. A., Ryanti, E., Haffiyan, Q., Widhiastuti, R., & Rizal. (2026). Plumbing System Planning (Clean Water and Wastewater Installation) at the Pontianak State Polytechnic Student Dormitory. *International Journal of Research in Vocational Studies (IJRVOCAS)*, 5(4), 35–44. <https://doi.org/10.53893/ijrvocas.v5i4.223>.

Received: 10 16, 2025; Revised: 11 20, 2025; Accepted: 12 25, 2025; Published: 01 30, 2026



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Abstract: The Pontianak State Polytechnic Student Dormitory consists of four floors with a capacity of 345 people, which has been dependent on water supply from the Regional Water Company (PDAM). Water availability is often disrupted, especially in the morning. Therefore, this study aims to design a plumbing system that integrates rainwater harvesting (RWH) as an alternative water source, along with clean water and wastewater systems that comply with national standards. The methodology used includes water demand analysis based on the number of residents, evaluation of rainwater harvesting potential from the roof, reservoir capacity calculations, pump specifications, and piping networks up to the septic tank based on Indonesian National Standards (SNI) and other standards. Additionally, the designed piping system considers distribution efficiency, adequate water pressure, and safe sanitation. Based on the calculation in this planning, the use of rainwater harvesting system can minimize PDAM usage by 11.18%. This plan is expected to provide a sustainable solution for clean water supply in the campus environment, particularly at the Pontianak State Polytechnic Student Dormitory.

Keywords: Plumbing, Clean Water, Wastewater, Rainwater Harvesting, Student Dormitory

1. Introduction

Water is a basic human need that is essential for maintaining food supplies and a productive environment. Water sources can include rainwater, surface water, and groundwater. After use, water becomes wastewater, which can come from household waste, industrial waste, rainwater runoff, and groundwater seepage. Plumbing systems closely relate to the everyday use of water. Planning a plumbing system is a vital aspect of building construction, especially in residential buildings such as student dormitories. This system includes clean water installations to meet daily needs and wastewater installations that function to dispose of used water so that it does not pollute the environment.

The Pontianak State Polytechnic student dormitory, a four-story building housing 345 residents, sources its water from rainwater, surface water, and groundwater. After use, this water becomes wastewater from domestic and industrial activities, rainwater runoff, and groundwater seepage. A well-planned plumbing system is essential for ensuring clean water supply and proper wastewater disposal in residential buildings. However, the dormitory frequently faces water flow issues, particularly between 06:00 and 10:00 AM, due to high usage, low water pressure, uneven distribution, as well as pipe leaks and blockages.

To address this issue, a feasible solution is a Rainwater

Harvesting System (PAH) and a redesign of the clean water system, based on data from the West Kalimantan Provincial Statistics Agency [1] indicating that rainfall in Pontianak is high throughout the year, with an average rainfall of 352 mm/month. Rainwater harvesting systems can reduce dependence on traditional water sources, save costs, and are environmentally friendly. They also help reduce the risk of flooding and support sustainable water use. Based on this background, the following problem formulation is obtained:

- 1). How to design a rainwater harvesting system in the student dormitory of Politeknik Negeri Pontianak?
- 2.) How to design a plumbing system (clean water supply and wastewater system) in the student dormitory of Politeknik Negeri Pontianak?

2. Methodology

In planning the clean water and wastewater plumbing system network for the Pontianak State Polytechnic Student Dormitory Building, a framework is needed to assist in the calculation and planning stages of the plumbing system. The following is the planning and calculation framework used for the plumbing system in the Pontianak State Polytechnic Student Dormitory Building, as shown in Figure 1.

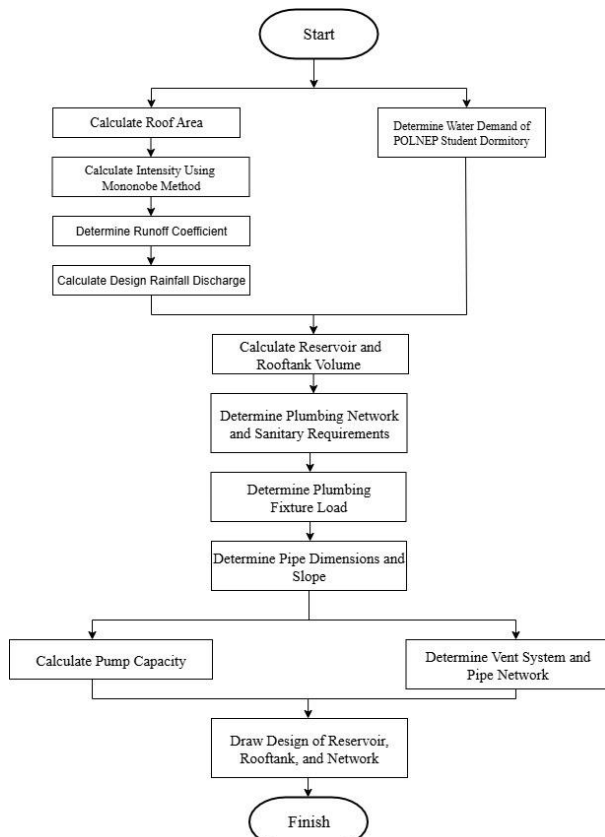


Figure 1 Calculation and Planning Diagram of The Final Project.

2.1. Research Location

First, confirm that you have the correct template for your

paper size. This template has been tailored for output on the A4 paper size. The Pontianak State Polytechnic Student Dormitory, situated at Jalan Ahmad Yani No. 1, Akcaya, Southeast Pontianak District, Pontianak City, West Kalimantan 78121, is the location for the plumbing system planning (clean water and wastewater implementation), as illustrated in Figures 2.



Figure 2 Sketch of the Location of the Pontianak State Polytechnic and The Dormitory.

2.2. Rainfall Data

In the planning of the plumbing system (clean water and wastewater installation) for the Pontianak State Polytechnic Student Dormitory, a rainwater harvesting system (RWH) is used, meaning that the clean water supply comes from rainwater, with the aim of reducing water usage from the PDAM. The following is the average rainfall data for the Pontianak location over the past 10 years, with RA as amount of rainfall, NR as number of rainy days, Max 1 RD as maximum amount of one rainy day of the month.

2.3. Water Availability

In RWH planning, rain data is needed to calculate the rainwater supply that can be accommodated based on the area of the rain catchment area or the area of the roof of the house, and also to calculate the discharge from the rain with a rational method to determine the gutters that will be used to drain water into the lower reservoir.

Calculating the roof area and determining the average rainfall per month to calculate the supply of rainwater with the Pythagorean theorem and the rain catchment area on the roof [2].

2.4. Utilization of PDAM and Volume of Ground Reservoir

Polytechnic dormitory building was only using taps, so by utilizing rainwater through the PAH system, the use of taps can be saved. The following is the procedure for calculating the percentage of PDAM savings. Calculate the average monthly rainfall for the last 10 years [3-12], find the average of the 10-year value, and determine the month with an average value close to the average value for a period of 10 years as a planning benchmark.

Table 1 Average Rainfall Data of Pontianak City from 2015 to 2024

Rainfall Data of Pontianak City, 2015-2024										
Month/Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
January	7.65	20.06	5.58	10.77	5.23	25.55	9.00	2.97	12.23	20.16
February	5.93	10.97	8.82	3.14	4.18	30.24	1.32	6.46	7.82	27.66
March	8.87	7.55	10.77	1.16	6.71	8.84	11.61	6.03	10.58	27.45
April	4.13	9.80	5.27	9.33	18.63	23.33	8.07	26.03	9.93	14.87
May	11.16	14.03	10.26	14.19	12.58	10.52	15.84	22.13	8.87	29.23
June	8.20	8.13	4.57	15.83	8.07	27.20	19.63	32.20	16.83	15.93
July	4.52	10.03	9.77	0.00	3.71	29.48	6.26	11.48	8.06	11.10
August	1.61	0.42	14.35	2.06	1.10	3.42	29.29	26.19	4.61	31.65
September	1.13	5.50	5.47	5.30	1.87	31.23	24.23	9.90	21.67	12.00
October	7.39	7.35	6.16	17.45	21.16	6.77	17.06	19.74	18.03	13.65
November	8.93	15.33	7.13	10.10	5.83	27.20	9.53	14.43	15.93	30.20
December	9.55	8.87	4.06	7.81	19.55	5.61	13.58	14.74	26.10	19.23
Average	12.4670591									

2.5. Roof Tank

The upper reservoir or rooftop tank is a tank placed on the rooftop or at a higher elevation than the building, functioning to distribute water through the plumbing system by utilizing gravity. In this system, the upper reservoir receives water from the lower reservoir, which is usually located at ground level, and the water is pumped upward due to the height difference between the two tanks. For the plumbing system planning of the dormitory building at Politeknik Negeri Pontianak, which consists of both male and female dormitories within the same building, the plumbing network is divided into two separate lines: one for the male dormitory and one for the female dormitory, based on the difference in the number of occupants. The female dormitory has a capacity of 196 people, while the male dormitory accommodates 148 people plus one dormitory guard, totaling 149 people. After determining the appropriate volume for the upper reservoir, the next step is to draw the system layout and calculate the required pipe lengths for water distribution, as well as to plan the strategic placement of the pump to ensure the water distribution system functions

efficiently. Roof tank effective capacity can be seen in the formula (1) [13] and (2) [14],

$$V_E = [(Q_p - Q_{h \max}) \times T_p] + (Q_{pu} \times T_{pu}) \tag{1}$$

$$Q_{h - \max} = Q_h \times C1 \tag{2}$$

Note:

- VE: Effective capacity of the upper tank (L)
- Qp: Peak demand (L/min)
- Qh max: Peak hourly demand (L/min)
- Qpu: Filling pump capacity (L/min)
- Tp: Duration of peak demand (minutes)
- Tr: Operating time of the filling pump (minutes)
- Qh-max: Water consumption during peak hour (m³/day)
- Qh: Average water consumption (m³/day)
- C1: Constant between 1.5 – 2.0 (depending on location, building usage characteristics, etc.)

2.6. Plumbing Installation

In determining the plumbing installation to be used, it can be adjusted to the working drawings or the actual conditions in the field. The plumbing installation in the Plumbing System Design (Clean Water and Wastewater Installation) for the Pontianak State Polytechnic Student Dormitory is adjusted to the actual conditions in the field.

2.7. Clean Water Piping Network

The piping network in this plan is divided into two parts: the clean water piping network and the wastewater piping network. The clean water piping network is designed to align with the existing plumbing installation in the Pontianak State Polytechnic dormitory building, considering the layout of the upper and lower reservoirs, as well as the calculation of pipe diameters and necessary accessories. The final stage involves drawing the clean water piping network within the building. As the piping networks for the male and female dormitories are planned separately; the design process is carried out twice. To calculate the diameter of the clean water pipes, the following method is used: first, determine the plumbing fixtures to be used and their average discharge capacity; second, calculate the total average discharge capacity of all plumbing fixtures; third, accumulate the total average discharge capacity to determine the water demand value; fourth, multiply the water demand value by a factor of 0.25, then use the result as the basis for selecting the appropriate pipe diameter using the reference table; and finally, draw or design the clean water piping network and determine the types of pipe connections required.

2.8. Clean Water Pipe Head Loss

Head loss calculated in clean water pipes uses the same

formula as head loss calculations in pumps, which consists of two types: major head loss due to friction with the pipe and minor loss due to the use of pipe connections/accessories. The head loss of the piping network is calculated on the top floor, considering that the top floor has the smallest value due to the small height difference between the upper reservoir and the distribution pipe [13].

2.9. Wastewater Piping Network

In determining the wastewater piping network, there are two important aspects that need to be considered, namely the use of plumbing fixtures and building plans. In addition, the wastewater piping network will be divided into two, namely the piping network that serves black water, or water from toilets, and grey water, or dirty water.

2.10 Septic Tank

Based on the number of residents in the female and male dormitories and the separation of their piping networks, the septic tanks used are also planned separately; however, the method of planning remains the same for both. The calculation of the number of septic tanks required involves several steps: first, calculate the volume of wastewater generated by using the average of 0.10 m³ per person and multiplying it by the number of residents in each dormitory; second, determine the appropriate size and diameter of the septic tank based on the total number of occupants and the resulting volume; and third, draw the septic tank design according to the calculated dimensions and create the corresponding piping network layout leading to the septic tank.

3. Results and Discussions

3.1. Number of Residents

The total number of female dormitory residents is 196, and the total number of male dormitory residents is 148. There is one dormitory supervisor, bringing the total to 345 people.

3.2. Rainwater Catchment Based on Roof Area

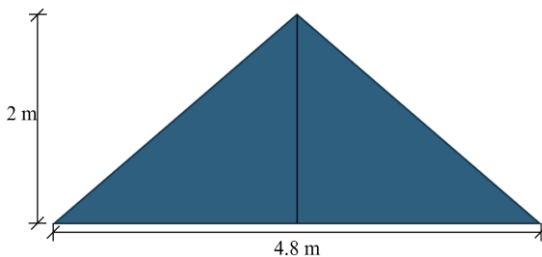


Figure 3 Roof Area

The rainwater catchment area based on one roof of the building can be calculated using the area of a rectangle, given that the length of the roof is 46.8 m. Based on data from the West Kalimantan Meteorology, Climatology, and Geophysics Agency, the average monthly rainfall over the last 10 years was highest in May 2024 at 508.6 mm/month or 0.5086 m/month. Therefore, the availability of rainwater that can enter with a surface runoff coefficient (C) of 0.8 is 300.067 m³.

3.3. Rainfall Intensity

Table 2 Average Maximum Rainfall Table

Maximum Rainfall Table					
Year	Maximum rainfall	Deviation (xi-x)	(xi-x) ²	(xi-x) ³	(xi-x) ⁴
2022	256	103.4	10691.56	1105507	1.1E+08
2021	200	47.4	2246.76	106496.4	5047930
2024	185	32.4	1049.76	34012.22	1101996
2023	175	22.4	501.76	11239.42	251763
2017	165	12.4	153.76	1906.624	23642.1
2020	154	1.4	1.96	2.744	3.8416
2018	115	-37.6	1413.76	-53157.4	1998717
2019	112	-40.6	1648.36	-66923.4	2717091
2016	85	-67.6	4569.76	-308916	2.1E+07
2015	79	-73.6	5416.96	-398688	2.9E+07
Total	1526		27694.4	431479.9	1.8E+08
Average	152.6				

Based on the calculations in the table, the standard deviation is 55.4721. To determine the Gumbel distribution value, it is necessary to use the Gumbel reduction factor (Kt). With an average annual maximum rainfall of 152.6 mm, a Kt value of 1.8489, and a standard deviation of 55.4721, the resulting Gumbel distribution value is 255.1673 mm. To calculate the maximum rainfall intensity using the Mononobe formula, both the maximum daily rainfall and the time of concentration must be determined. The maximum daily rainfall (R₂₄) is obtained from the Gumbel distribution, resulting in a value of 255.1673 mm. The time of concentration is calculated based on the roof slope, which is 0.833%, yielding a value of 0.0601 hours or approximately 3.6 minutes. Using these parameters, the maximum rainfall intensity is calculated to be 576.42949 mm/hour.

Table 3 (a) Clean Water Demands for Female and Male Dormitories (b) Clean Water Needs with Anticipating (c) Average Water Usage According to Hours of Use (d) Peak Hour Water Usage (e) Peak Minute Water Usage

Clean Water Demands for Female and Male Dormitories			
	Female	Male	Unit
P	196	149	Person
D	120	120	litres/person/day
Q	23520	17880	litres/day

(a)

Clean Water Needs for Female and Male Dormitories Anticipating Shortage of Water Flow			
	Female	Male	Unit
Q1	23520	17880	litres/day
20% x Q1	4704	3576	litres/day
Qd	28224	21456	litres/day

(b)

Average Water Usage According to Hours of Use			
	Female	Male	Unit
Qd	28224	21456	litres/day
t	8	8	hour
Qh	3.528	2.682	m ³ /hour

(c)

Peak Hour Water Usage			
	Female	Male	Unit
Qh	3.528	2.682	m ³ /hour
C1	1.75	1.75	coefficient
Qh max	6.174	4.6935	m ³ /hour

(d)

Peak Minute Water Usage			
	Female	Male	Unit
Qh/60	0.0588	0.0447	m ³ /hour
C1	3.5	3.5	coefficient
Qm max	0.2058	0.15645	m ³ /minute

(e)

3.4. Rational Flow Rate Methode

Based on a rainfall intensity of 0.00016 m/second and a gable roof area of 368.741 m², the rainfall runoff was calculated using the Rational Method. According to SNI 03-2453-2002 on urban drainage planning, the runoff coefficient for continuous apartment areas ranges from 0.6 to 0.75. A

value of 0.7 was adopted, following the recommendation from Drainase Perkotaan by Soemarto (1986). $Q = 0.278 \times 0.7 \times 576.42949 \text{ mm/hour} \times 368.741 \times 10^{-6} \text{ km}^2$. Thus, the rainfall discharge using the rational method is 0.41361 m³/second.

3.5. Gutter

Based on the rainfall intensity in Pontianak City, which is 576.42949 mm/m²/hour or equivalent to 9.60716 litres/minute, and a roof area of 184.37062 m², the total rainfall can be calculated using the formula: Total Rainfall = Roof Area × Rainfall Intensity, resulting in 184.37062 m² × 9.60716 litres/minute = 177.28 litres/minute. To anticipate potential heavy rainfall events, this value is multiplied by a factor of 3, giving an anticipated total rainfall of 531.83 litres/minute. Based on this anticipated flow rate, three 3-inch diameter pipes are used to ensure the drainage system can accommodate the runoff effectively, considering both the roof area and the drainage pipe capacity.

3.6. Ground Reservoir

The ground reservoir will store the daily water needs for all dormitory residents; therefore, its volume is the accumulation of water usage from both the female and male dormitories, which is calculated as: Qd total = Qd female + Qd male = 28.224 m³ + 21.456 m³ = 49.68 m³. Based on this total water demand, a rectangular underground reservoir with dimensions of 5 meters in length, 5 meters in width, and 2 meters in height is planned, resulting in a total volume of 50 m³, which is sufficient to meet the daily water requirements.

3.7. Roof Tank

In calculating the roof tank, it is first necessary to determine the peak demand period and the pump filling period. Based on the example from the book Design and Maintenance of Plumbing Systems by Soufyan M. Noerbambang and Takeo Morimura, the peak demand period (Tp) is assumed to be 30 minutes, and the pump filling period (Tpu) is 10 minutes. The peak hour flow rate (Qh max) is then converted into litres per minute [14].

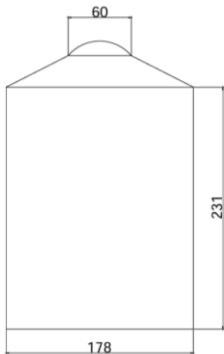
Roof Tank Volume			
	Female	Male	Unit
Qp = Qm max	205.8	156.45	litres/minute
Qh max	102.9	78.225	litres/minute
Tp	30	30	minute
Qpu	205.8	156.45	litres/minute
Tpu	10	10	minute
VE	5145	3911.25	litres

(a)

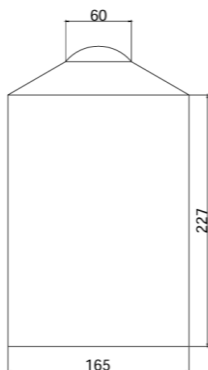
Peak Hour Water Usage (L/minute)			
	Female	Male	Unit
Qh max	6.174	4.6935	m ³ /hour
t	60	60	minute
Qh max	102.9	78.225	litres/minute

(b)

Since the peak demand (Qp) is equal to the peak minute demand, the pump flow rates for each dormitory are: 205.8 litres/minute for the female dormitory and 156.45 litres/minute for the male dormitory. Using these values, the roof tank volume for each dormitory can be calculated. As there is no commercially available rooftop tank with an exact capacity of 5,145 litres for the female dormitory, a 5,200-litre tank is used instead, with dimensions of a 1.78 m bottom diameter, 0.6 m top diameter, and 2.31 m height. Similarly, for the male dormitory, a 4,100-litre tank is used in place of the exact required capacity of 3,911.25 litres, with specifications including a 1.65 m bottom diameter, 0.6 m top diameter, 2.1 m height, and a total volume of 4,100 litres.



(a)



(b)

Figure 4 Roof Tank Dimension (a) Female Dormitory (b) Male Dormitory

3.8. Roof Tank

To determine the appropriate type of pump, it is essential to consider both the water flow rate and the required pump head [5]. In the design of the POLNEP student dormitory water system, the pump is intended to transfer water from the ground-level reservoir to the rooftop tank. For calculation purposes, the distance to the male dormitory's upper tank is used, as it is longer than the distance to the female dormitory's tank. However, the daily flow rate applied in the calculation is based on the female dormitory, since its water usage is higher. The selected pump system includes both suction and discharge components.

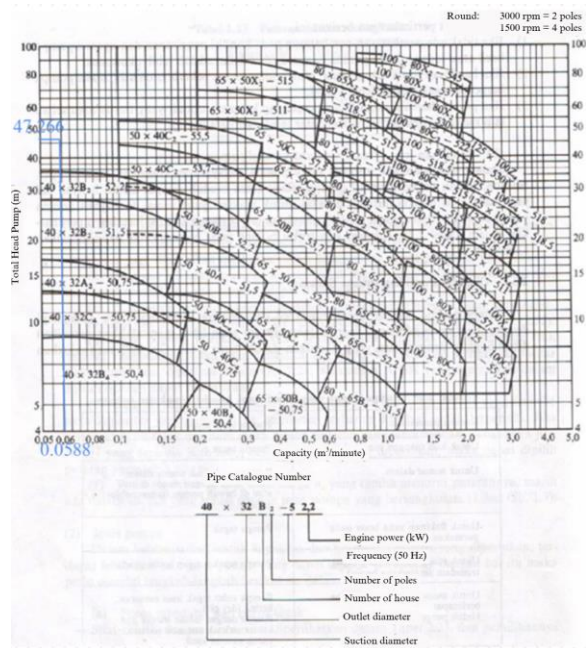


Figure 5 Pump Power Graph

3.9. Roof Tank

In determining the diameter of the clean pipes to be used, disposal capacity can be used. In the POLNEP Student Dormitory building, there are several types of plumbing fixtures listed in the following table:

Table 4 Number of Plumbing Fixtures Unit in the Dormitory

Number of plumbing fixtures	Total (Unit)	
	Female	Male
Toilet	15	16
Bidet	15	16
Lavatory	16	16
Shower	15	14
Kitchen sink	5	4
Wudhu faucet	6	0
Laundry Faucet	5	5

Following the number of plumbing fixtures, the equipment discharge capacity based on the total of plumbing fixtures for female is 5280 liters/minute, and for male is 4720 liters/minute. This number is from each plumbing water needs multiplied by number of plumbing. The following table will provide detailed information.

Table 5 Total Plumbing Fixtures (L/minute)

Female Plumbing Fixtures	Number	Water (L/Minit)	Total
Toilet	15	120	1800
Shower	15	50	750
Lavatory	16	90	1440
Kitchen sink	5	90	450
Laundry faucet	5	60	300
Wudhu Faucet	6	90	540
Total (liter/minute)			5280

Male Plumbing Fixtures	Number	Water (L/Minit)	Total
Toilet	16	120	1920
Shower	14	50	700
Lavatory	16	90	1440
Sink dapur	4	90	360
Laundry	5	60	300
Total (liter/minute)			4720

Table 6 Pipe Diameter for Clean Water

	Equipment discharge capacity (liters/minute)	Water needs (liters/minute)	Multiplier 0.25	Pipe diameter (inches)
Female	5280	360	90	1 1/4
Male	4720	240	60	1

Therefore, pipe diameter for female pipeline dormitory is 1 ¼ inch and for male is 1 inch, respectively.

3.10. Roof Tank

Each plumbing unit has a plumbing fixture unit, this number should be multiplied with the number of plumbing in order to produce total of plumbing fixture unit value. The tables below illustrate the value of female and male plumbing fixture unit in total before simultaneous flow.

Table 7 Total of Plumbing Fixture Unit

Male Sanitary	Number	Plumbing Fixture Unit Per Unit	Plumbing Fixture Unit
Closet	16	2.5	40
Bidet	16	1	16
Shower	14	2	28
Lavatory	16	1	16
Kitchen Sink	4	1.5	6
Laundry	5	1.5	7.5
Total			113.5

Female Sanitary	Number	Plumbing Fixture Unit Per Unit	Plumbing Fixture Unit
Closet	15	2.5	37.5
Bidet	15	1	15
Shower	15	2	30
Lavatory	16	1	16
Kitchen Sink	5	1.5	7.5
Laundry	5	1.5	7.5
Wudhu Faucet	6	2	12
Total			125.5

From the total load units of plumbing fixtures, which are 125.5 in the female's dormitory and 117.5 in the male's dormitory, they are plotted on the plumbing fixture load unit curve with simultaneous flow, resulting in a flow rate in the girls' dormitory of 290 liters/minute or 0.0048 m³/second and 270 liters/minute or 0.0045 m³/second in the boys' dormitory, as can be seen in Figure 6. With a velocity (v) in accordance with the standard of 0.6 - 1.2 m/s, with a maximum limit of 1.5 - 2 m/s, the planned velocity is 1 m/s.

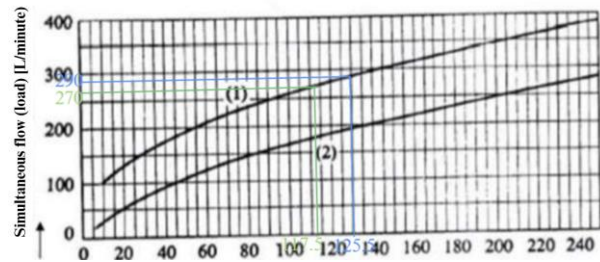


Figure 6 Simultaneous Flow

3.11. Clean Water Pipe Headloss

Before calculating pressure loss or head loss in a piping system, it is necessary to first identify the accessories or equipment used in the pipes, such as pipe fittings, valves, and bends. These components play a significant role as they can cause energy losses during fluid flow. Once the components have been identified, the next step is to calculate the major losses, which are caused by friction between the fluid and the inner wall of the pipe, and the minor losses, which result from flow disturbances due to fittings, valves, and bends within the system.

The detail of fitting that is being used in the dormitory alongside with the number and coefficient is shown in table 8.

Table 8 Types and Number of Pipe Connections in the Clean Water Network of the Pontianak State Polytechnic Student Dormitory

Fittings	Female N fitting	Male N fitting	Coefficient
Rounded elbow 90	21	20	0.2
Tee flanged run	2	1	0.3
Tee flanged brunch	50	45	1
Cross run	3	3	0.5
Cross brunch	3	3	0.75
Union	4	7	0.08

Number of minor losses can be calculated using the formula (3) [16].

$$Hf_{minor} = n \times k \frac{v^2}{2g} \quad (3)$$

Note:

Hf minor: Minor friction loss due to pipe accessories (m)

K: Coefficient of accessory type

V: Average flow velocity (m/s)

g: Gravitational acceleration (9.8 m/s²)

For example:

$$Hf_{minor\ 90} = 21 \times 0.2 \times 1^2 / (2 \times 9.81)$$

$$= 0.214 \text{ m}$$

Table 9 will exhibit the minor losses data.

Table 9 Minor Losses in Clean Water Pipeline Network

Fittings	Female N fitting	Male N fitting	Coefficient	Female Hf min	Male Hf min
Rounded elbow 90	21	20	0.2	0.214067278	0.2038736
Tee flanged run	2	1	0.3	0.03058104	0.01529052
Tee flanged brunch	50	45	1	2.54841998	2.29357798
Cross run	3	3	0.5	0.076452599	0.0764526
Cross brunch	3	3	0.75	0.114678899	0.1146789
Union	4	7	0.08	0.016309888	0.0285423
Hf minor total				3.000509684	2.7324159

Meanwhile, for the mayor losses is using formula (4) [13].

$$Hf_{mayor} = \frac{L}{(0.2785 \times D^{2.63} \times C)^{1.85}} \times Q^{1.85} \quad (4)$$

Note:

Hf mayor: Major head loss / major pressure loss (m)

Q: Water discharge (L/s)

D: Pipe diameter (cm)

L: Pipe length (m)

Table 10 Mayor Losses in Clean Water Pipeline Network

	Pipe length	Flow rate	c PVC	Pipeline diameter	Hf mayor (m)
Female dormitory	179.03	4.833333	130	8	2.58160099
Male dormitory	181.923	4.5	130	8	2.29846336

Based on the calculation of head losses, which consist of both major losses due to friction and minor losses from fittings, valves, and bends, the total head loss or pressure drop is determined using the equation: Head losses = Hf major + Hf minor + H residual pressure. Given that the head losses account for 30% of the static head, and the static head—comprising the building height and rooftop tank height—is 14.3 meters, the resulting head losses amount to 4.29 meters. From this value, the residual pressures in the piping networks are calculated: -1.2948 meters for the female dormitory and -0.7387 meters for the male dormitory. These negative values indicate insufficient pressure, necessitating additional elevation of the rooftop tanks to meet the required residual pressure of 10 meters, as stipulated in SNI 8153:2015. Therefore, the necessary support heights for the tanks are 11.2948 meters for the female dormitory and 10.7387 meters for the male dormitory. Considering that the actual height of the dormitory building to the roof slab is 11.9 meters, it can be concluded that the existing structure is adequate to achieve the required residual pressure.

3.12. Wastewater Piping Network

In determining the appropriate diameter for the drainage pipes, it is essential to consider the plumbing fixture unit load and the type of wastewater—grey water and black water. Based on these factors, 3-inch diameter pipes are selected for toilet drainage in the female dormitory, while 4-inch pipes are used in the male dormitory. For general wastewater drainage in both dormitories, 4-inch diameter pipes are also applied. The selected wastewater pipe diameters serve as a reference for sizing the vent pipes, with 2-inch diameter vent pipes being used, in accordance with UPC-2012 [17] standards, to support both 3-inch and 4-inch waistlines. Additionally, to ensure proper flow and prevent blockages, horizontal wastewater pipes must be installed with a specific slope. A minimum slope of 1/8 inch per foot, or approximately 1.04%, is required for both 3-inch and 4-inch pipes [18]. Table 11 will provide grey wastewater vertical drainpipe data from average power output which is a value from plumbing fixture number multiplied by average discharge per plumbing fixture, and table 15 will provide black wastewater vertical drainpipe, a total average power output from numbers of closet multiplied by average of discharge.

Table 11 Toilet Pipes (Grey Water Pipes)

Plumbing Fixture	Number		Average discharge (L/Minute)	Total average power output (Liter/Minute)	
	Female	Male		Female	Male
Lavatory	16	16	90	1440	1440
Shower	5	14	50	250	700
Kitchen sink	5	4	90	450	360
Keran wudhu	6	0	90	540	0
Keran laundry	5	5	60	300	300
Total				2980	2800
Vertical Drain Pipe				1 piece 4 inch	1 piece 4 inch

Table 12 Toilet Pipes (Black Water Pipes)

	Number of Closet	Average discharge (L/Minute)	Total average power output (Q Wasterwater) (Liter/Minute)	Vertical Drain Pipe
Female	15	120	1800	1 piece 3 inch
Male	16	120	1920	1 piece 4 inch

3.13. Wastewater Piping Network

The design of the septic tanks is based on SNI 2398:2017 with the minimum distance to the clean water source is 10 meters [19], which stipulates the use of separate tanks for male and female dormitories to align with the segregated piping system. The female dormitory is designed to accommodate 196 individuals, while the male dormitory houses 149 individuals, including dormitory staff. With an estimated average wastewater production of 0.10 m³ per person [17], the required septic tank capacities are determined to be 20 m³ for the female dormitory and 16 m³ for the male dormitory.

Table 13 Septic Tank Size and Volume

	Number of people	Volume Size based on number of people (m3)	Septic Tank Size	Septic Tank Volume (m3)
Female	196	19.6	2.2 x 5.4 x 2	20
Male	148	14.8	1.8 x 5.4 x 2	16

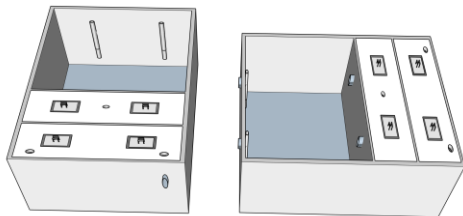
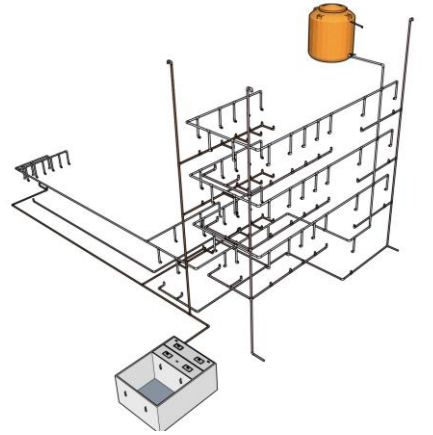


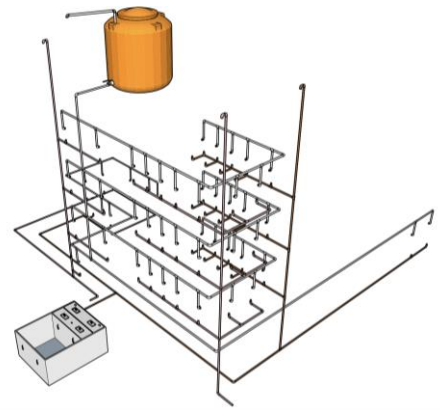
Figure 7 Septic Tank Design

3.14. Wastewater Piping Network

The results of calculations and analysis in the planning of clean water and wastewater plumbing systems in the Pontianak State Polytechnic Student Dormitory building, the results of the clean water and wastewater piping networks are as shown in Figures 8.



(a)



(b)

Figure 8 Clean Water and Wastewater Piping Network in the (a) Female and (b) Male Dormitory

3.15. Wastewater Piping Network

Given that the daily ground reservoir volume based on Table 4.6 is 44.1266 m³/day and the daily water requirement is 49.68 m³/day, the potential savings in PDAM usage are 11.1783 %.

Table 14 Volume of Ground Reservoir

Date	Amount of Rainfall (mm)	Supply Volume (m ³)	Accumulation of rainfall amount (m ³)	Volume of water used per day (m ³ /day)	Accumulation of water used (m ³)	Discrepancy (m ³)
1	0	0	0	49.68	49.68	-49.68
2	0	0	0	49.68	99.36	-99.36
3	0	0	0	49.68	149.04	-149.04
4	0	0	0	49.68	198.72	-198.72
5	0	0	0	49.68	248.4	-248.4
6	0	0	0	49.68	298.08	-298.08
7	0	0	0	49.68	347.76	-347.76
8	0	0	0	49.68	397.44	-397.44
9	0	0	0	49.68	447.12	-447.12
10	56	33.03921	33.0392148	49.68	496.8	-463.76079
11	4	2.359944	35.3991587	49.68	546.48	-511.08084
12	0	0	35.3991587	49.68	596.16	-560.76084
13	17	10.02976	45.4289203	49.68	645.84	-600.41108
14	75	44.24895	89.6778686	49.68	695.52	-605.84213
15	60	35.39916	125.077027	49.68	745.2	-620.12297
16	99	58.40861	183.485639	49.68	794.88	-611.39436
17	65	38.34909	221.834728	49.68	844.56	-622.72527
18	0	0	221.834728	49.68	894.24	-672.40527
19	0	0	221.834728	49.68	943.92	-722.08527
20	0	0	221.834728	49.68	993.6	-771.76527
21	0	0	221.834728	49.68	1043.28	-821.44527
22	0	0	221.834728	49.68	1092.96	-871.12527
23	0	0	221.834728	49.68	1142.64	-920.80527
24	0	0	221.834728	49.68	1192.32	-970.48527
25	0	0	221.834728	49.68	1242	-1020.1653
26	0	0	221.834728	49.68	1291.68	-1069.8453
27	0	0	221.834728	49.68	1341.36	-1119.5253
28	0	0	221.834728	49.68	1391.04	-1169.2053
29	0	0	221.834728	49.68	1440.72	-1218.8853
30	0	0	221.834728	49.68	1490.4	-1268.5653
31	0	0	221.834728	49.68	1540.08	-1318.2453
Max						49.68
Min						1318.24527
Volume of Ground Reservoir per month (m ³ /month)						1367.92527
Volume of Ground Reservoir per day (m ³ /day)						44.1266217

4. Conclusion

Based on the analysis of the “Plumbing System Planning (Clean Water and Wastewater Installation) at the Pontianak State Polytechnic Student Dormitory,” it is concluded that PDAM water is still required, as the rainwater harvesting (RWH) system alone cannot fully meet the clean water demand. However, the RWH system can reduce daily PDAM usage by 11.1783%. A 50 m³ ground reservoir will be placed above ground, and water will be pumped to two separate roof tanks—5,200 liters for the female dormitory and 4,100 liters for the male dormitory—using a CR 3-10 vertical multistage centrifugal pump with a 1.5 kW motor. Clean water and wastewater systems are designed separately for each dormitory, with daily clean water needs of 28,224 liters for females and 21,456 liters for males. The clean water piping network uses 1¼-inch and 1-inch diameter pipes, while the wastewater network uses 4-inch diameter pipes. Gutters are planned to use three 3-inch pipes, and the clean water flow velocity is set at 1 m/s. Separate septic tanks are used for black water—20 m³ for females and 16 m³ for males—while grey water is directed to a control tank.

Acknowledgements

The authors would like to express their deepest gratitude to Politeknik Negeri Pontianak, especially to the Civil Engineering department, for their invaluable material and moral support in facilitating this research. The author also expresses appreciation to all individuals and organizations that have contributed to the completion of this research.

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