FINAL PROJECT – CL234801

DETAILED ENGINEERING DESIGN OF RAINWATER HARVESTING SYSTEM AS THE PROVISION OF DRINKING WATER (CASE STUDY OF AL KAHFI INTEGRATED ISLAMIC BOARDING SCHOOL IN BOGOR REGENCY)

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ENVIRONMENTAL ENGINEERING DEPARTMENT

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APPROVAL SHEET

DETAILED ENGINEERING DESIGN OF RAINWATER HARVESTING SYSTEM PLANNING AS AN ALTERNATIVE FOR PROVISION DRINKING WATER (CASE STUDY AL KAHFI INTEGRATED ISLAMIC BOARDING SCHOOL BOGOR REGENCY)

FINAL PROJECT

Submitted to fulfil one of the requirements
For obtaining a degree Bachelor of Engineering at
Undergraduate Study Program of Environmental Engineering
Department of Environmental Engineering
Faculty of Civil, Planning, and Geo-Engineering
Institut Teknologi Sepuluh Nopember

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SURABAYA
JULY 2024

STATEMENT OF ORIGINALITY

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hereby declare that the Final Project with the title of "Detailed Engineering Design of Rainwater Harvesting System as the Provision of Drinking Water (Case Study of Al Kahfi Integrated Islamic Boarding School in Bogor Regency" is the result of my own work, is original, and is written by following the rules of scientific writing.

If in the future there is a discrepancy with this statement, then I am willing to accept sanctions in accordance with the provisions that apply at Institut Teknologi Sepuluh Nopember.

Surabaya, July 29, 2024

Acknowledged
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DETAILED ENGINEERING DESIGN OF RAINWATER HARVESTING SYSTEM AS AN ALTERNATIVE FOR PROVISION DRINKING WATER (CASE STUDY AL KAHFI INTEGRATED ISLAMIC BOARDING SCHOOL BOGOR REGENCY)

Student Name / NRP : **Annisa Sofia Afifah / 5014201120**

Department : **Environmental Engineering FTSPK – ITS**

Advisor : **Ainul Firdatun Nisaa, S.T., M.Sc.**

Abstract

Water scarcity, exacerbated by population growth, climate change, and poor water quality, necessitates sustainable water supply, drought prevention, ecological balance, and environmental protection. The high demand for water at Al Kahfi Integrated Islamic Boarding is a result of its large student population and changing water use habits. Groundwater has been the primary source, but continuous extraction could lead to land subsidence. Rainwater harvesting is an effective solution to address water issues, especially in Bogor Regency, where the school receives 2500-5000mm of annual rainfall. The study investigates the quality and quantity of rainwater and groundwater at Al Kahfi Integrated Islamic Boarding School. Rainwater samples were collected from the dormitory roof and groundwater samples from the nearest tap. The potential amount of rainwater collected was calculated using daily rainfall, catchment area, and runoff coefficient. The clean water demands of residents were compared with the potential amount of rainwater. Water gutter dimensions were determined using table from SNI 03-7065-2005 after obtain rainfall intensity data. The laboratory tests showed that the rainwater collected from various rainwater gutters consistently surpassed the drinking water quality limits for both E. Coli and total coliform parameters. At certain intervals, it exhibits low pH levels, high turbidity, coloration, and elevated levels of manganese and chromium. The rain at the Al Kahfi Islamic boarding school is measured in terms of rain intensity. It was observed that the rain intensity in the male student area ranged from 84.1 mm/hour to 179.73 mm/hour. The range for the female student area is 59.11 mm/hour to 160,59 mm/hour. The estimated percentage of rainwater that can be used as an alternative drinking water for buildings A, B, C, D, E, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, and V based on period of one decade are, 87%, 68%, 77%, 47%, 60%, 61%, 45%, 44%, 51%, 46%, 68%, 54%, 53%, 62%, 113%, 82%, 82%, 94%, and 50% respectively. A rainwater harvesting system is proposed for all dormitory buildings, except Usaid, Maria Qibtiyah, Aisyah, and Khodijah. The collected rainwater is stored in tanks with capacities of 12 m3, 8 m3, 10 m3, 3 m3, 11 m3, 15 m3, 8 m3 and 5 m3 respectively for dormitory buildings A, B, C, D, E, G, H, and I. while for buildings K, L, M, N, O, P, Q, R, S, T, and V respectively 4 m3, 4 m3, 4 m3, 11 m3 ,10 m3, 5 m3, 10 m3, 5 m3, 5 m3, 5 m3 and 3 m3. The rainwater will be treat by t using activated carbon filter and ozonation. Subsequently, the water is briefly kept in ground reservoir prior being sent to the tap. The total estimation cost budget for designing a rainwater harvesting system at Al Kahfi Islamic Boarding School is IDR 1,080,000.00

Keywords: ***Annual Rainfall, Catchment Area, Integrated Islamic Boarding School, Rainfall Intensity, Rainwater Harvesting.***

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While preparing this report, it was recognized that there are still several shortcomings. Positive feedback and suggestions for improvement are highly encouraged for future reports, with the aim of enhancing the quality of the author's work. It is hoped that this report, created by the author of this arrangement, would prove beneficial to all of us.

Surabaya, 26th July 2024

Writer

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CHAPTER I

INTRODUCTION

1.1 Background

Water is one substance that exists naturally on the surface of the earth. Unfortunately, a lot of people on the earth suffer from water shortages since not everyone has access to enough clean water. Many factors, such as uneven water distribution, population growth and rising demand, climate change, deteriorating water quality, and many more, are contributing to the shortage of clean water (Lestari et al., 2021). Water conservation is essential for preserving sustainable water supplies, lowering the possibility of drought, and preserving ecological balance. Water conservation also helps lower the strain on aquifers, lakes, and other natural resources, reducing environmental damage, dropping water levels, and maintain the quality of water.

Al Kahfi Integrated Islamic Boarding School is an educational institution with 6.2 ha of area and located in Jalan Desan Srogol, Cigombong District if the Bogor Regency. This Islamic boarding school has a high number of student population, which results in a high demand for water. Groundwater has been the source of the water used till now. The academic community in this islamic boarding school draws the groundwater from one well. The groundwater Land subsidence will occur if significant volumes of groundwater are continuously extracted. In addition, there is a higher probability of groundwater depletion and other environmental harm if there is a future increase in the number of students attending Islamic boarding schools and modified water usage patterns. Land subsidence is a geological danger that is mostly caused by human activities such as excessive mining of underground fluids (water or hydrocarbons). Groundwater extraction has reduced water levels by more than 40 meters in certain regions. This large drop resulted in substantial sinking of the ground surface (Zhu et al., 2015). The community has recently suffered the effects of climate change, which includes reduced surface water sources in certain areas. Pumping of groundwater must thus increase to meet demand. Groundwater and other natural fluids play a major role in the ecosystem's maintenance. The surface of the soil will become distorted due to a large decrease in pore pressure and compaction caused by excessive groundwater extraction (Sajjad et al., 2023). Groundwater usage in CAT Bogor was found to cause the restricted aquifer system, especially resulting in a 0.06 – 5.07 m/year drop in water level and changes in the quality of the water (Rengganis & Harnandi, 2011).

To conserve the ground water, one of the several methods is rainwater harvesting (RWH). A few nations have begun to put this concept into practice. Global experiences with RWH demonstrate improved soil moisture, replenished groundwater, decreased runoff, and heightened crop productivity, all these guaranteed farmers' access to food and a ,\stable living (Singh et al., 2019).Water supply techniques including rainwater harvesting (RWH) and reuse have been around for a while. Rainwater storage and long-term planning of usage are typically beneficial to civilization's progress. RWH has the power to decrease greenhouse gas emissions, increase water supply, and prevent pluvial floods (Raimondi et al., 2023). Rainwater harvesting system (RHWS) are influenced by economic conditions and local regulations. The national Movement for Water Saving Partnership (GNKPA) Program emphasizes rainwater harvesting through building’s roofs. The increasing awareness of environmental conservation and global warming’s reduction in clean water demand for green buildings (Wigati et al., 2022).

The Al-Kahfi Islamic Boarding School region is a great place to investigate the alternative use of rainwater collecting. This is a result of the location of the Islamic boarding school in Bogor Regency which has 2,500 – 5,000 mm of rain annually ((Asnur, 2021).

Harvesting rainwater also reduces runoff, which usually leads to disruptions to the routine of the islamic boarding school.

1.2 Problem Identification

The following are some formulations of problems in this rainwater harvesting system planning as an alternative for supply clean water demands in Al Kahfi Integrated Islamic Boarding School:

1. How is the quality and quantity of rainwater at the Al Kahfi Integrated Islamic Boarding School in Bogor?
2. How might a rainwater collection system be designed in the Al Kahfi Integrated Islamic Boarding School to provide the alternate requirement for drinking water?
3. What are the bill of quantity (BOQ) and Cost Budget Plan (RAB) for the planning of a rainwater harvesting system?

1.3 Objective

The following are the goals of this planning:

1. Analyzing the quality and quantity of rainwater at the Al Kahfi Integrated Islamic Boarding School in Bogor.
2. Planning an alternative rainwater collection system as the alternate requirement for drinking water in the Al Kahfi Integrated Islamic Boarding School.
3. Calculate the value of the bill of quantity (BOQ) and plan cost budget (RAB) construction cost for the rainwater harvesting system.

1.4 Scope

The Following scope are used in this planning:

1. A rainwater harvesting system will be planned at the Al Kahfi Integrated Islamic Boarding School in Bogor
2. The water quality parameters are based on Minister of Health Regulation No. 2 of 2023
3. The research time will be carried out from January-July 2024
4. The Analysis will focus on the technical aspect
5. The scope of technical planning include:
   a. Design of ground reservoir for each dormitory building
   b. The gutter system includes horizontal pipes that gather rainfall from the roof (gutter) and vertical pipes that carry rainwater into water storage, and drainpipes that discharge first rainwater to the ground.
   c. Determination and calculation of rainwater treatment building units if needed

1.5 Benefits

The following are some benefits of this research:

1. Author has the opportunity to create a rainwater harvesting system in order to fulfil the demands for clean water
2. Make suggestion regarding alternative to fulfil the demands for clean water to Al Kahfi Integrated Islamic Boarding School.
3. Provide information regarding alternative technologies for clean water requirement by utilization rainwater to public.

CHAPTER II

LITERATURE STUDY

2.1 Previous Research

Previous research findings are used as a guide and source material for new research. Several studies address rainwater harvesting methods. The summary of previous research on harvesting rainwater can be seen in the **Table 2. 1** below

Table 2. 1 Previous Research

No.	Researcher (Year)	Research Title	Research Summary
1	Cendya Quaresvita (2016)	Perencanaan Sistem Pemanenan Air Hujan Sebagai Alternatif Penyediaan Air Bersih (Studi Kasus Asrama ITS) (Design of Rainwater Harvesting System as Clean Water Supply Alternative (Case Study ITS Dormitory)	The goal of this project was to develop a rainwater harvesting system for the ITS dorms as a substitute for PDAM water. The research suggests that rainwater harvesting in dormitories could potentially save up to Rp 17,000,000.00 per month during the rainy season. The system considers the quality and quantity of rainwater collected, with a pH value of 6.75, hardness of 35.71 mg/L, and total dissolved solids of 336mg/L. This is in line with Minister of Health Decree No.492 (2010), which allows rainwater to be used as clean water.
2	Fadlilatin Nailah (2018)	Perencanaan Rainwater Harvesting dan Pengolahan Air Limbah di Pondok Pesantren Mambaul Ulum Bata-Bata Pamekasan (Design of Rainwater Harvesting and Wastewater Treatment in Islamic Boarding School Mambaul Ulum Bata-bata Pamekasan)	The goal of this study was to develop waste management and rainwater collection systems for an Islamic boarding school in the Pamekasan Regency with the number of students in 2016 was 10,216 students. In the female dormitory obtained the capacity of rainwater storage tank is 347.76 m3 and 469.52 m^3 in male dormitory. Meanwhile the ABR in female dormitory have 4 compartments with a total dimension of 21.2 x 4.3 x 4.3 m and in the male dormitory designed ABR with 3 compartments and the total dimensions of 23.43 x 4.3 x 3.8 m. Based on the economic feasibility analysis with NPV and BCR this design is eligible.
3	Armin Zuliarti and Satyanto Krido Saptomo (2021)	Perencanaan Penampungan Air Hujan dengan Filtrasi Sederhana Skala Unit Rumah di Perumahan Villa Citra Bantarjati (Design of Rainwater Storage with Simple Filtration in House Unit Scale in Villa Citra Bantarjati Housing)	The research aims to improve rainwater storage volume and Villa Citra Bantarjati housing design and filtration tools to improve the physical quality of rainwater for household use. Primary data, including roof area and rainfall data from the last 15 years, was used. Water quality testing was conducted before and after filter device design to meet class II standards. The average volume of available rainwater stored in rainwater reservoirs is 155.31 L/day, with a water loss factor of 20% for runoff. The rainwater storage capacity is 330 L.

No.	Researcher (Year)	Research Title	Research Summary
4	Arthenesya Syaron Berlian (2023)	Perencanaan Sistem Penampungan Air Hujan Sebagai Salah Satu Alternatif Sumber air Bersih di Rusunawa Siwalankerto dan Aparna Graha Utama Ahmad Yani Surabaya (The Rainwater Storage Planning System in Rusunawa Siwalankerto and Aparna Graha Utama Ahmad Yani Surabaya: An Alternative Source of Clean Water)	The goal of this project is to collect rainwater as clean water source in two flats. The existing water storage can accommodate rainwater, eliminating the demand for new storage. The rainwater meets quality standards, but a disinfection unit is needed for total coliform parameters. After chlorination, rainwater can be stored in soil reservoirs mixed with PDAM water. Rusunawa Siwalankerto's system can save PDAM water usage by 23% per month, costing IDR 22,405,500,00. Aparna Graha Utama Ahmad Yani's system can save PDAM water usage by 40% per month, costing IDR 147,190,000,00.

2.2 General Description of The Study Area

The Al Kahfi Integrated Islamic Boarding School is located in Jalan Desa Srogol in the Cigombong District of the Bogor Regency. Male and Female dormitories are located in different location on the 6.2-hectare facility of Al Kahfi Integrated Islamic Boarding School. There are four educational institutions being run by Al Kahfi Integrated Islamic Boarding School, namely Madrasah Aliyah (MA), integrated Islamic Junior High School (SMPIT), Integrated Islamic High School (SMAIT), and Kindergarten (TK). This Islamic boarding school is surrounded by villages, plantations, and rice fields. The picture that shows the location of The Al Kahfi Integrated Islamic Boarding School can be seen in the **Figure 2. 1** below.

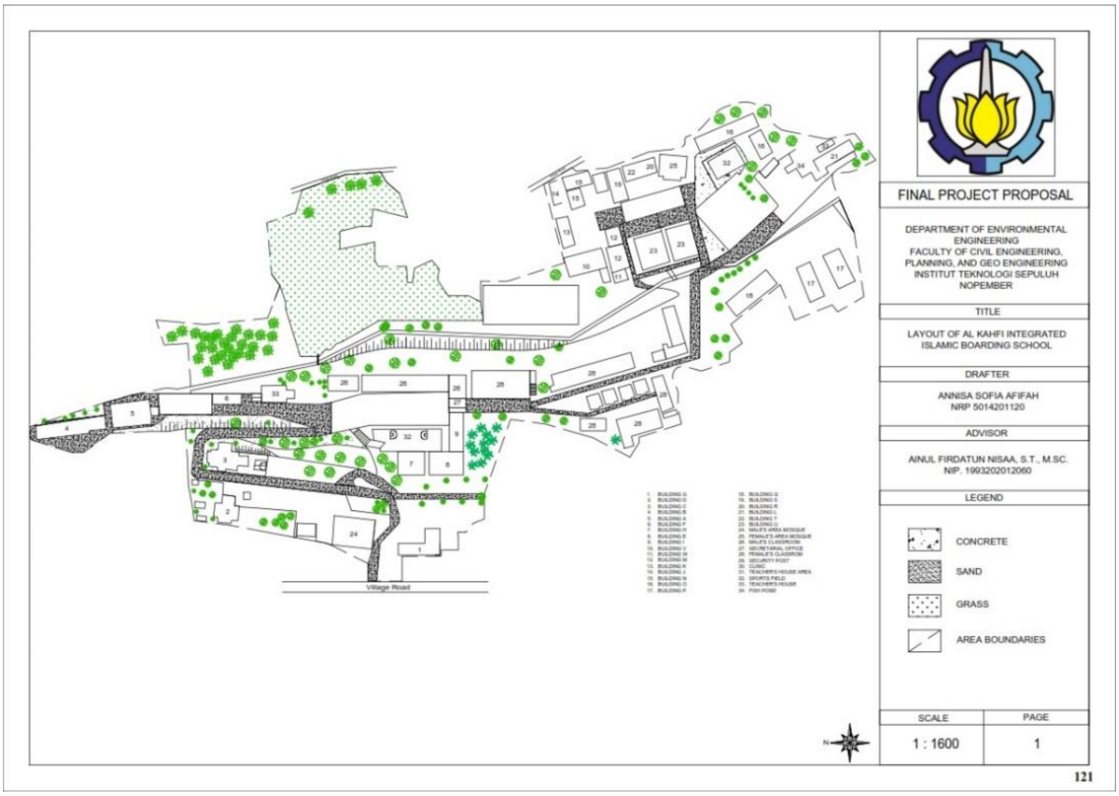


Figure 2. 1 Site Location of Al Kahfi Integrated Islamic Boarding School

2.2.1 Buildings and Facilities

Al Kahfi integrated Islamic boarding school is facilitated by variety of facilities to support the activities of the students, such as dormitories, mosques, classrooms, clinics, halls, minimarkets, public kitchen, fields, and other. There are exactly fifteen male dorms and seventeen female dorms in total. According to Mr. Nugraha as the secretary of the Al Kahfi integrated Islamic boarding school, Numerous dorms may be housed in one building. To make naming them simpler, the male student area's dormitory building are named A to I buildings, and the female student area's dormitories are named J to W buildings. The list of dormitory buildings including the occupant capacity of each building can be seen in the **Table 2. 2** and **Table 2. 3**

Table 2. 2 Building Capacity for Male Dormitory

Building	Dormitory	Occupant Capacity
A	Usman	60
B	Ali	66
C	Abu	70
D	Arman	44
E	Hamzah	138
F	Usaid	130
G	Umar	92
H	Mus'ab	82
I	Khalid	66
Total		748

(Source: Secretariat of Al Kahfi Integrated Islamic boarding school)

Table 2. 3 Building Capacity for Female Dormitory

Building	Dormitory	Occupant Capacity
J	MaQi	186
K	Umsal	66
L	Asma	90
M	Sofiyah	24
N	Khonsa	170
O	Hafsoh	160
P	Saudah	44
Q	Fatimah	36
R	Zainab 1	24
S	Zainab 2	24
T	Zainab 3	24
U	Aisyah	88
	Khodijah	
V	Shofiyah B	38
Total		974

(Source: Secretariat of Al Kahfi Integrated Islamic boarding school)

Certain dormitory buildings are equipped with rain gutters. **Figure 2. 2** and **Figure 2. 3** are show the building that equipped gutter and standpipe

Figure 2. 2 Building Equipped with Gutter

Figure 2. 3 Building Equipped with Standpipe

2.2.2 Clean Water Network

Groundwater is presently the source of clean water for the Al Kahfi Islamic Boarding School environment. Groundwater is drawn from a deep well in the center of the Islamic boarding school area, pumped to an elevated reservoir which near the mosque in male dormitory area, and then directed toward the buildings of the Islamic boarding school use gravity principle. **Figure 2. 4** below are shown the ground reservoir in the Al Kahfi.

Figure 2. 4 Communal Reservoir in Al Kahfi Islamic Boarding School

Figure 2. 5 is the picture that shows the current state of clean water network, comes from an Islamic boarding school.

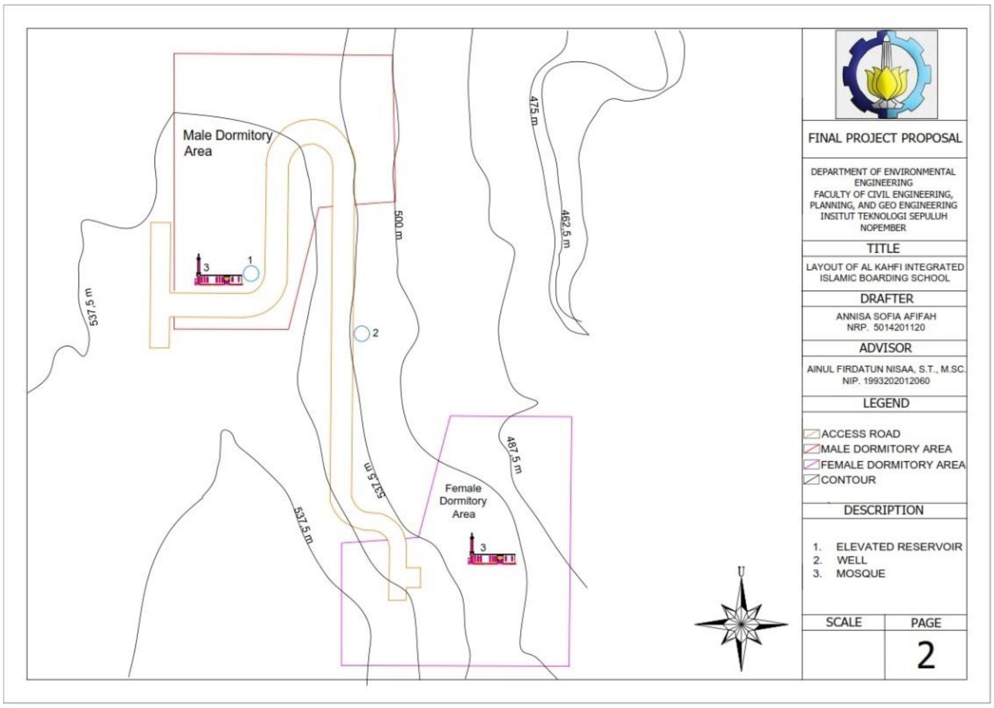


Figure 2. 5 Layout of Al Kahfi Integrated Islamic Boarding School

2.3 Rainwater Harvesting System

Rainwater harvesting is a technology that gathers and treats rainwater from rooftops, terraces, court yards, and other impermeable building surfaces for on-site consumption with the goal to reduce the amount of drinking water from centrally manage source (Campisano et al., 2017). Since the world cannot provide the growing demand for clean water, rainwater harvesting is a potential solution to the problem of clean water shortages in the future. Large amount of rainwater is not properly gathered because of evaporation, surface runoff from shallow soil with shallow surface, and low-quality plants. Rainwater harvesting are therefore helpful for maximizing the amount of rainfall (Ertop et al., 2023).

A rooftop rainwater harvester is one method of collecting rainwater. It is installed on the roof and uses a variety of components to direct rainfall from the water catchment area into a storage tank via pipes or drains. In order to guarantee efficient pre-treatment procedures, certain rainwater collecting systems are furthermore equipped with treatment components, such as filters (particularly sand, gravel, and charcoal filters) (Anchan & Shiva Prasad, 2021). **Figure 2. 6** is shows the illustration of rainwater harvesting system.

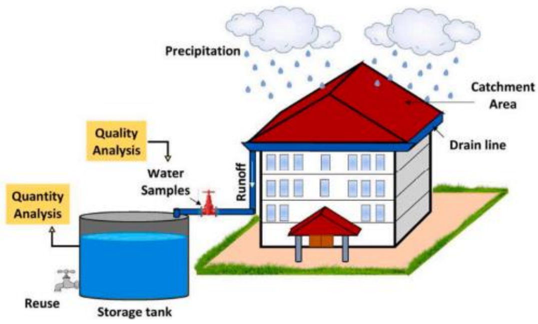


Figure 2. 6 Rainwater Harvesting Scheme
(Source: Anchan & Shiva Prasad, 2021).

2.4 Rainwater Quality

The quality of rainwater varies geographically. Rainwater collected from the roof is subject to various factors such as its material (chemical properties, roughness, surface layer, age, etc.), its location (close to or not from a pollution source), its physical boundary conditions (size, slope, direction, exposure), water vapor pressure, the solubility of pollutants in water, the intensity and volume of atmospheric precipitation, the season, weather patterns, and the length of previous dry periods (Förster, 1998).

2.5 Quality Standard of Drinking Water

To prevent any unwanted effects on consumers, it is important to consider the quality of drinking water. Minister of Health Regulation No. 2 of 2023 provides into the requirements for drinking water quality conditions. A few guidelines that need to be maintained when testing drinking water can be seen in the **Table 2. 4** below

Table 2. 4 Quality Standards of Drinking Water

No	Parameter	Quality Standard	Unit
1	*E. Coli*	0	CFU/100ml
2	Total Coliform	0	CFU/100 ml
3	Temperature	Air Temperature ±3	^{0}C
4	Total Dissolve Solid	<300	mg/L
5	Turbidity	<3	NTU
6	Colour	10	TCU
7	pH	6.5 – 8.5	-
8	Nitrite	3	mg/L
9	Chromium	0.01	mg/L
10	Iron (Fe)	0.2	mg/L
11	Manganese (Mn)	0.1	mg/L
12	Lead (Pb)	0.01	mg/L
13	Fluoride (F)	1.5	mg/L
14	Aluminium (Al)	0.2	mg/L

(Source: Minister of Health Regulation No. 2 of 2023)

2.6 Hydrological Analysis

Hydrological cycle is also known as the cycle of water illustrates the constant flow of water from the surface of the land and sea to the sky and back again in the form of precipitation. The first phase of the hydrological cycle is the evaporation of water caused by solar radiation in lakes, se and other bodies of water. Water also evaporates from the leaves of trees through evapotranspiration. Condensation occurs when steam rises and returns to the land and sea as precipitation. Rainfall shapes the surface of earth and falls as surface water, creating rivers and lakes. Rainfall seeps through the pores in the soil to generate aquifers. In the end, some surface and subterranean water makes it is way into the ocean (Inglezakis et al., 2016). The figures that illustrate the process of hydrological cycle can be seen in the **Figure 2. 7**.

Figure 2. 7 Hydrological Cycle
(Source: Inglezakis et al., 2016)

Environmental and human activity changes can have impacts on the water cycle. Hydrological models are developed to comprehend and analyze the water cycle. The creation of hydrological models was prompted by a number of water-related concerns. Such as flood control, water management, and water building design. They also been used in recent decades to look at reservoir operations, potential impacts of land use or climate change, and real-time hydrodynamic river flow routes (Wang et al., 2021).

2.6.1 Calculations of The Average Rainfall in an Area

The outcomes of rain gauge observations are sometimes referred to as local rain data (point rainfall) as they typically only measure one location. There may be differences in the rain data gathered at the several rain stations spread out over a watershed. The conversion of point rainfall into areal rainfall is necessary since many hydrological analyses need average rainfall data from river basins (rainfall area). The three types of methodologies that may be used to find the rainfall area are the average methodology Arithmetic Mean method, the Thiessen polygon method, and the isohyet method. Here is the explanation of each of them.

a. Arithmetic Mean Method

This approach is the simplest method for determining the areal rainfall. Utilized in locations with several rain gauges that are evenly distributed on flat terrain. The arithmetic mean technique considers that the rainfall field is homogeneous and that rain gauge readings are independent, therefore it assigns equal weight to each rain gauge (Rakhecha & Singh, 2009). The magnitude of the rainfall area can be calculated with the following equation.

$$\bar{R} = \frac{1}{n}\sum_{i=1}^{n} R_i \qquad (1)$$

Where:

$\bar{R}$ = Area Rainfall

R_i = Point Rainfall

n = Number of Station

b. Thiessen Method

This method, referred to as a weighting factor, includes elements that affect the region that rain gauge stations represent. Thiessen is frequently used to determine typical periods of high rainfall when the rain station is not distributed evenly

(Arianti et al., 2021). The Thiessen approach determines a region by drawing polygons connecting its stations. **Figure 2. 8** is shows the polygon of Thiessen

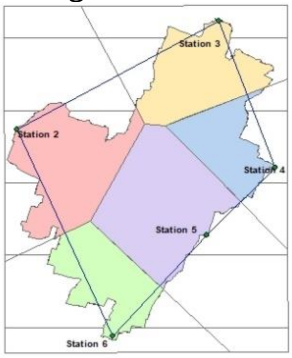


Figure 2. 8 Thiessen Polygon

The average rainfall height is calculated the size of each polygon multiplied by the rainfall height and divided by the total area. The following are the equation to calculate the average rainfall height.

$$\bar{R} = \frac{1}{n}\sum_{i=1}^{n} W_i \ x \ R_i \quad (2)$$

Where:

$\bar{R}$ = Area Rainfall
R_i = Point Rainfall
n = Number of Station
W_i = Thiessen coefficient at station i
Thiessen coefficient can be calculated by following equation

$$W_A = \frac{A_A}{A} \quad (3)$$

Where:

W_A = Thiessen coefficient at station A
A_A = The area of influence for station A
A = Total Area of watershed
W_i = Thiessen coefficient at station i

c. Isohyet Method
The most comprehensive approach is the isohyet technique. It is a technique for drawing line that connects locations with equivalent precipitation levels. This method may also be used to determine the rainfall mapping patterns in a region where rainfall will be mapped (Nurhijriah et al., 2022). According Nailah and Masduqi (2018) the following are the equations of average rain in watershed

$$P = ((\frac{A_1}{A_t} \text{ x } \frac{P_1+P_2}{2}) + (\frac{A_2}{A_t} \text{ x } \frac{P_2+P_3}{2}) + \ldots + (\frac{A_n}{A_t} \text{ x } \frac{P_n+P_{n+1}}{2})) \quad (4)$$

Where:
P = Average of Rainfall (mm)
$P_{1\ldots}P_n$ = The same height of rain on each isohyet line (mm)
$A_{1\ldots}A_n$ = Area Bounded by Isohyet lines (km^2)

A_t = Total Area of Watershed (km^2)

2.6.2 Maximum Daily Rainfall

To determine the maximum daily rainfall, there are two methods that can be used, are the normal distribution method and Gumbel Method.

a. Normal Distribution Method

According to Purba et al (2021), this method also known as Gauss distribution. The following are the equation of normal distribution method.

$$K_T = \frac{X_T - \bar{x}}{S} \quad (5)$$

Where:

X_T = An estimate of the value that is expected to occur with a return year
$\bar{x}$ = Average Value
S = Deviation Standard
KT = Frequency factor

b. Gumbel Distribution Method

Gumbel distribution is often used in rainfall frequency analysis. The gumbel distribution is a popular statistical method for predicting extreme hydrological events such floods (Bhagat, 2017). According to Quaresvita (2016), the following are the equation of Gumbel distribution method.

$$X_{Tr} = \bar{x} + \frac{(Y_{Tr} - Y_n)}{\sigma_n} \text{ x S} \quad (6)$$

Where:
X_{Tr} = Magnitude of variable with a return period of T years
$\bar{x}$ = Average Value
S = Deviation Standard
K = Frequency factor of Gumbel
Yn = Reduced mean depends on the number of samples
σ_n = Reduced standard deviation (depending on the number of samples)
Y_{Tr} = Reduced Variable

2.6.3 Rainfall Intensity Analysis

Rainfall intensity is related to the duration and frequency of rain. According to Purba et al (2021), The mononobe equation to determine rainfall intensity and the equation to determine concentration time are shown below

$$I = \frac{R_{24}}{24} \text{ x } \left(\frac{24}{tc}\right)^{\frac{2}{3}} \quad (7)$$

Where:
I = Rainfall intensity (mm/h)
R_{24} = Design Rainfall, maximum daily (mm)
tc = Concentration Time (hour)

Time concentration (tc) refers to the duration it takes for water to move from the highest point of the rain collecting surface (such as the top of the roof) to the roof drainage channel (such as the gutter). The Kirpich method is a technique used to calculate time concentration, and it is represented by the following equation.

$$tc = \left(\frac{0.87 \ x \ Lo^2}{1000 \ x \ S}\right)^{0.385}$$ (8)

Where:

tc = Concentration Time (hour)

Lo = longest path length (m)

S = slope of channel

2.7 Drinking Water Requirements

According to SNI 03-7065-2005, every building needs to have a daily drinking eater demand that is determined by the daily water use of every individual based on building usage. The minimum water requirements based on building usage can be seen on the **Table 2. 5**

Table 2. 5 Use of Drinking Water According to Building Use

No.	Building Usage	Water Usage	Unit
1	Residential Houses	120	L / occupant / day
2	flats	100	L / occupant / day
3	Dormitories	120	L / occupant / day
4	Hospitals	500	L/bed/day
5	Elementary school	40	L/student/day
6	junior high school	50	L/student/day
7	high school/ vocational school and above	80	L/student/day
8	shophouse/office	100	L/occupant and employee/day
9	Office or factory	50	L/employee/day
10	Department store	5	L/m2
11	retail store	15	L/seat
12	restaurants	250	L/seat
13	star hotel	150	L/bed/day
14	Budget hotels/inns cinema theatre	10	L/seat
15	multipurpose building station	25	L/seat
16	terminal	3	L/Passenger
17	worship facilities	5	L/capital (Not including ablution water)

(Source: SNI 03-7065-2005)

The following are the equation to find the water demands.

$$B = D \ X \ P \ X \ 30$$ (9)

Where:

B = Total water requirement in a month (m^3)

D = The daily water requirements of one person (m^3)

P = Number of users (capital)

2.8 Rainwater Harvesting System Calculation

2.8.1 Calculation of Rainwater Harvesting System components

The parts of a rainwater harvesting system usually consist of a rain catchment area, a conduit for collecting rainfall that leads to a storage tank, and a reservoir.

a. Catchment Area

The roof of a home or other structure serves as the collection area. Water quality and collection efficiency are influenced by roof construction materials and effective roof area. Both quality and quantity are influenced by smooth roofing and materials that are clean and watertight (Abdulla & Al-Shareef, 2009).
The catchment area is also impacted by the shape of the roof. There are several types of the roof, however flat roof, gable roof, and shield roof are the most popular types. The following are the formula that used to calculate the surface area of the roof.

$$\text{Roof Area} = [L + 2(\text{roof overhang})] \times [W + 2(\text{roof overhang})] \quad (10)$$

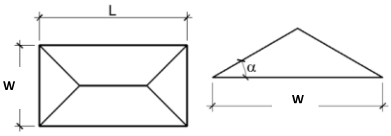


Figure 2. 9 Roof Area

Figure 2. 9 is shows the width and the length of the roof. When determining the roof area, overhang is considered in addition to the roof's length and width. A roof overhang is a portion of the structure that extends outside the building to give the impression that it is hanging free of walls.

b. Collecting Pipe

Rainwater that falls on a roof is normally transported to a tank via gutters or pipes. The size of pipe and the slope must be appropriate to collect as much harvest water as feasible. The size of pipe is determined by the catchment area and the amount of rainfall. The most common pipe materials are plastic, fiberglass, stainless steel, and galvanized steel (Abdulla & Al-Shareef, 2009). **Table 2. 6** are the list of roof gutters according to SNI 03-7065-2005

Table 2. 6 Maximum Allowable Roof Gutter Load (in M^2 of Roof)

Pipe Size (mm)	Rainwater Standpipe	Rainwater Drainage Flat Pipe			Open flat roof gutters			
		Slope			Slope			
		1%	2%	4%	1/2%	1%	2%	4%
50	63							
65	120							
80	200	75	105	150	15	20	30	40
100	425	170	245	345	30	45	65	90
125	800	310	435	620	55	80	115	160
150	1290	490	700	990	85	125	175	250
200	2690	1065	1510	2135	180	260	365	520
250		1920	2710	3845	330	470	665	945
300		3090	4365	6185				
350		5525	7800	11055				
Note: This table uses an hourly rainfall of 100 mm. Increased rainfall necessitates changing the area value in the table above by multiplying the result by 10 and dividing the value by the additional rainfall measured in millimetres per hour. For rainwater standpipes that are neither cylindrical nor pipe-shaped, any form that the pipe can fit inside the cross-section of is allowed. Roof gutters that don't have a circular form must have the same cross-sectional area.								

(Source: SNI 03-7065-2005)

c. Storage Tank

There are several options for the dimension of tank, shape, and construction materials (brick, stone, cement brick, plain cement concrete, and reinforced cement concrete). The form of the tank might be square, rectangular, or cylindrical. Form, size, and material choices are made with the area of rainwater harvesting demands in consideration (Abdulla & Al-Shareef, 2009). There are two kinds of reservoir, namely ground reservoir which are some or all of structures located below the soil surface and elevated reservoir which are the structures located at a specific height above the soil surface. The following formula can be used to determine the volume of storage tank.

$$V = S - B \tag{11}$$

Where:
V = Volume of storage tank at the end of the month (m^3)
S = Supply of rainwater to the storage tank in one month (m^3)
B = Water demand in one month (m^3)

2.8.2 Calculation of Rainwater Harvesting Supply

Water harvest potential is the entire amount of water that can be used for harvesting. The following is the equation of production or harvest capacity.

$$S = A \, x \, M \, x \, F \tag{12}$$

Where:

S = Rainwater Supply (m^3)
A = Projected Area (m^2)
M = Average Rainfall (mm/month)
F = Runoff coefficient

The coefficient of runoff depends on the material that the runoff passes through. **Table 2. 7** are the list of some runoff coefficients.

Table 2. 7 Runoff Coefficient

No.	Area Type	Runoff Coefficient
1	Business	
	Urban Area	0.70 – 0.95
	Sub urban area	0.50 – 0.70
2	Housing Area	
	Single House	0.30 – 0.50
	Multiunit	0.40 – 0.60
	Separate Multiunit	0.60 – 0.75
	Combined Village	0.25 – 0.40
	Apartment	0.50 – 0.70
3	Industry	
	Light	0.50 -0.80
	Heavy	0.60 – 0.70
4	Pavement	
	Asphalt and Concrete Bricks	0.50 – 0.80
	Paving	0.60 -0.90
5	Roof	0.75 – 0.95
6	Courtyard, sandy soil	
	Flat 2%	0.50 – 0.10
	Average 2-7%	0.10 – 0.15
	Steep 7%	0.15 – 0.20

No.	Area Type	Runoff Coefficient
7	Courtyard, heavy soil	
	Flat 2%	0.13 – 0.17
	Average 2-7%	0.18 – 0.22
	Steep 7%	0.25 – 0.35
8	Railway Yard	0.10 – 0.35
10	Playground Park	0.20 – 0.35
11	Forest	
	Flat 2%	0.10 -0.40
	Average 2-7%	0.25 – 0.50
	Steep 7%	0.30 – 0.60

(Source: Mc Gueen, 1989 in Suripin (2004)

The coefficient of runoff also can be calculated by the following equation.

$$Cr = \frac{Runoff\ volume}{The\ amount\ of\ water\ that\ surface\ drops} \quad (13)$$

2.9 Simple Rainwater Treatment Methods

The TP2AS (Tong Pengaduk Pompa Aerator Saringan) is a simple technology which used to process water into drinking water. This drinking water treatment is an inexpensive, easily operated, and basic drinking water processing instrument intended for domestic usage. (Herlambang, 2018). There are several steps that make up the processing phases, are:

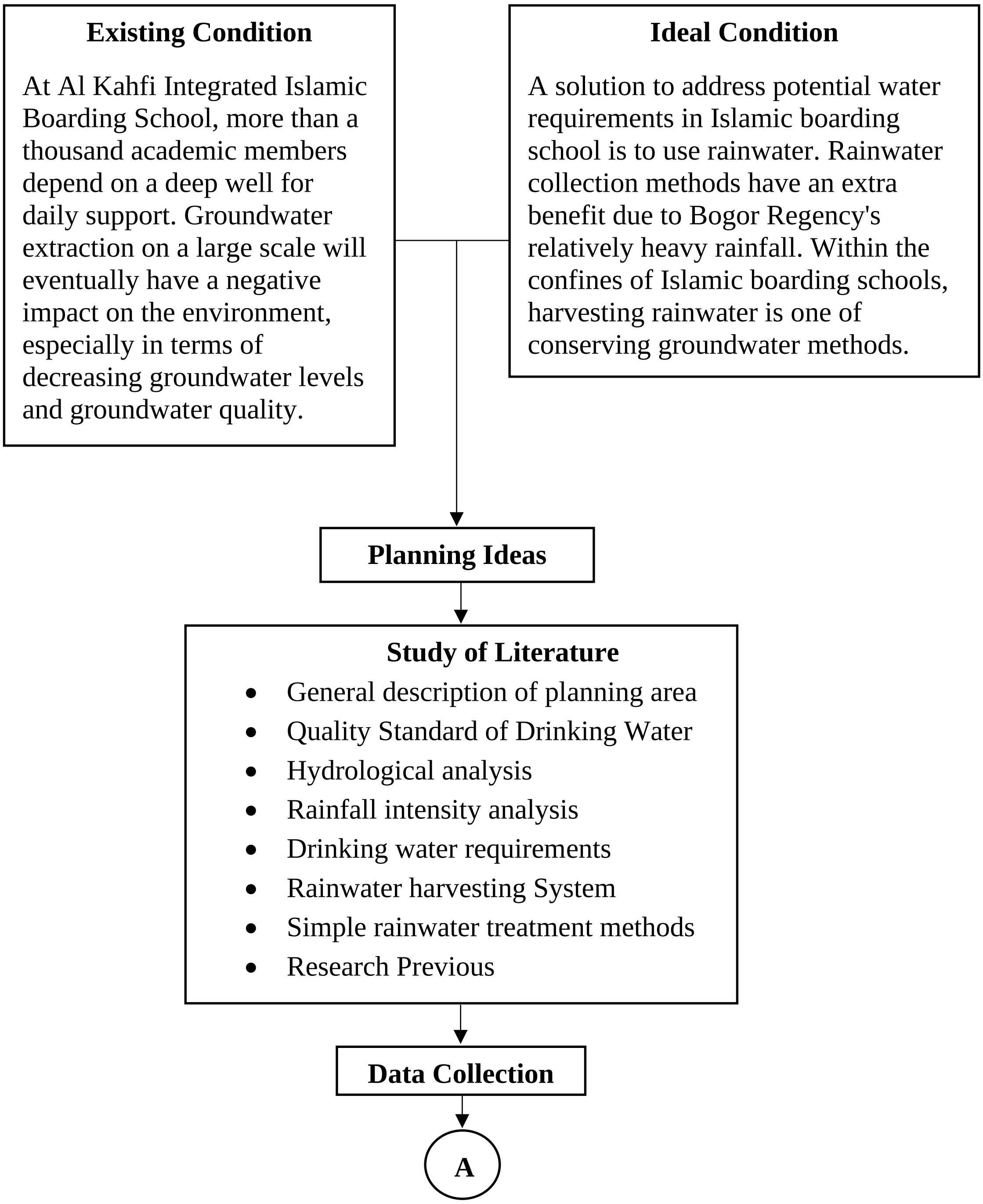
1. Neutralization
   As it relates to the provision of drinking water, neutralization is the process of adjusting the pH of water within an acceptable range, often between 7-8. An excessively acidic or alkaline water will corrode the distribution system and decrease the potable water quality. A simple treatment for acidic water is to add soda ash (Na_2CO_3) or lime (Ca $(OH)_2$) (Herlambang, 2018).
2. Aeration
   The process of treating water by getting into contact with air is called aeration. This aeration process aims to decrease CO2, increase dissolved oxygen, eliminate harmful CH4 (which produces odor), decrease Fe and Mn in water, and remove H2S. By using this application, precipitated chemicals will yield sediment (Febriyana & Masduqi, 2020).
3. Coagulation
   Coagulation is the act of introducing chemicals to the water that will be eliminated in subsequent solid/liquid separation procedures in order to combine smaller particles into one bigger aggregate (floc) (Jiang, 2015). The chemical formula for alum/alum, which has the common usage of coagulant, is Al2(SO4)3. To use, dissolve the alum in water first, then add it to raw water and stir rapidly for about two minutes. The speed is then lowered until lumps or flocs occur (Herlambang, 2018).
4. Precipitation
   Particles that have undergone coagulation will settle to the bottom of the tank. The sediment is removed by opening the drain valve, which is located at the bottom of the tank.
5. Filtering
   It is difficult to settle every floc during the settling process. It will be challenging for light, tiny particles to settle. This demands for a filtering procedure. To filter water, one can use a simple filter that works with materials like gravel, palm fiber, fine sand, charcoal, and fabric.

CHAPTER III

METHODOLOGY

3.1. General Description

The planning of using rainwater as a substitute for other sources of clean water is discussed in this plan. The Al Kahfi Integrated Islamic Boarding School in Bogor becomes the research site for this planning case study. The planning framework is designed to aid in the methodical implementation of planning activities through providing an outline of each step. The planning framework can be seen in the **Figure 3. 1** below.



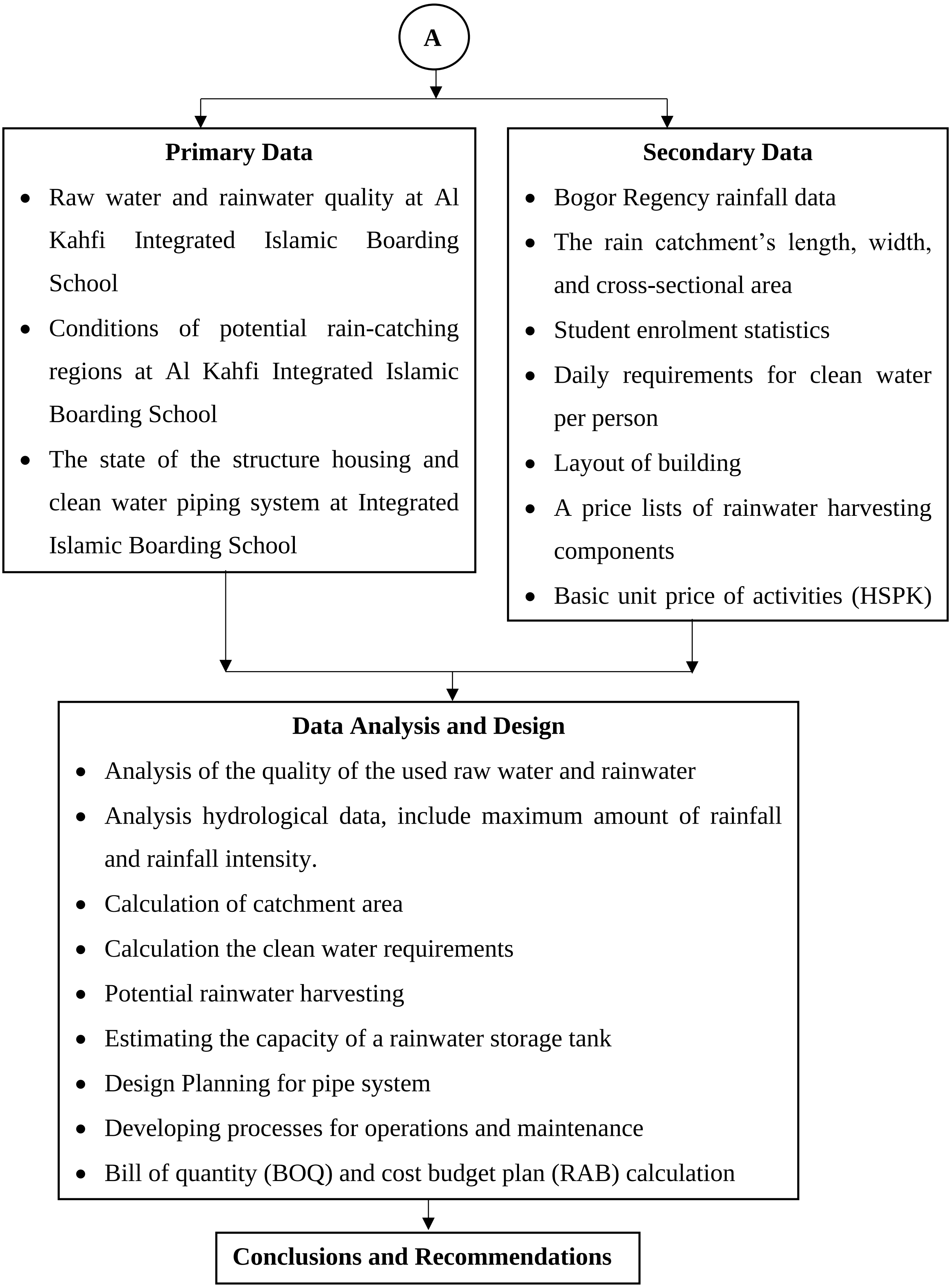


Figure 3. 1 Planning Framework

3.2. Research Framework

The planning framework comprises a sequence of stages of planning that may be defined as follows.

1. Planning Ideas

The Al Kahfi Integrated Islamic Boarding School in Bogor continues to often face issues with both the quality and quantity of its clean water supply. An alternate technique of enhancing the clean water supply would be beneficial, considering the high demand for clean water in Integrated Islamic Boarding Schools. This provided the foundation for this planning proposal with the support of Bogor Regency's typically heavy rainfall.

2. Study of Literature

To obtain information that clarifies planning ideas and getting supporting data for planning activities, literature reviews were conducted. International and national research publications, previous research papers with similar findings, and textbooks provide the literature that was utilized in this planning. The following are lessons to be learned from literature:

- General description of planning area
- Quality standard of drinking water
- Hydrological analysis
- Rainfall intensity analysis
- Drinking water requirements
- Rainwater harvesting System
- Simple rainwater treatment methods
- Previous research

3. Data Collection

This planning has made use of both primary and secondary data. Field studies are also conducted to gather data on the current situation and to collect samples of rainwater and raw water at the planning area. The information gathered comprises:

a. Primary Data

The quality of the rainwater is the primary data that required to determine whether the treatment unit is needed. Tests are also done on groundwater that is regularly used to determine whether it is possible to combine with the rainwater that has been gathered through rainwater harvesting. Samples were collected on the spot and examined at the Bogor District regional health laboratory and at the Bogor City regional health laboratory. The parameters that were tested are listed at the **Table 3. 1** below.

Table 3. 1 Parameters and Testing Methods for Rainwater and Groundwater Samples

No	Parameter	Quality Standard	Unit	Method
1	*E. Coli*	0	CFU/100ml	SNI / APHA
2	Total Coliform	0	CFU/100 ml	PU / APHA
3	Temperature	Air Temperature ±3	^{0}C	SNI / APHA
4	Total Dissolve Solid	<300	mg/L	SNI / APHA
5	Turbidity	<3	NTU	SNI /Equivalent
6	Colour	10	TCU	SNI / APHA
7	pH	6.5 – 8.5	-	SNI / APHA
8	Nitrite	3	mg/L	SNI / APHA
9	Chromium	0.01	mg/L	SNI / APHA
10	Iron (Fe)	0.2	mg/L	SNI / APHA
11	Manganese (Mn)	0.1	mg/L	SNI / APHA
12	Lead (Pb)	0.01	mg/L	SNI / APHA
13	Fluoride (F)	1.5	mg/L	SNI / APHA
14	Aluminium (Al)	0.2	mg/L	SNI / APHA

- Rainwater sampling

Collect rainwater samples using sterile bottles as indicated in SNI 06-2412-(1991).

1) Disinfect the bottle by rinsing it with distilled water three times
2) Allow the rain run for 10 minutes to removes the impurities in the gutters
3) Calibrate the bottle by filling it with rainwater three times by inserting a little rainwater into the bottle, shutting the bottle, shaking the bottle, and discarding the water.
4) Fill the bottle with rainwater
5) The bottle carrying the sample is labelled and immediately put into a cooling box equipped with ice gel

- Using pH and TDS Meter
    1) Adjust the tool's settings by utilising buffer powder that has been dissolved in 250 cc of distilled water.
    2) Activate the device and immerse it in a pH 4 solution until the gadget's display indicates a reading of 4.
    3) Immerse the tool in distilled water to achieve neutralisation.
    4) Submerge the tool into a solution with an alkaline pH level of 9 until the tool's display indicates the number nine.
    5) Deactivate the tool by using distilled water.
    6) Subsequently, the instrument can be utilised to quantify the pH, TDS, and temperature of water samples.

Furthermore, the condition of potential rain-catching regions and state of the structure housing and clean water piping system at Integrated Islamic Boarding School also required. This information is essentials for determining the component of rainwater harvesting system that required and the suitable location for install the system.

b. Secondary Data

The following secondary data were utilized in this planning:

- Bogor Regency rainfall data
- The rain catchment’s length, width, and cross-sectional area
- Student enrolment statistics
- Daily needs for clean water per person
- Layout of building
- A price lists of rainwater harvesting component

4. Data Analysis and Design

After collecting both primary and secondary data, data processing and discussion were conducted. The Al Kahfi Integrated Islamic Boarding School used the data that was gathered and processed to design a rainwater collection system as a clean water alternative. The following data processing methods were applied to support this planning:

a. Analysis of the quality of the used raw water and rainwater. Several criteria of clean water that are examined and compare to Minister Health regulation no. 2 of 2023. Tested samples included raw water for usage and rainwater. The rainwater test results will indicate whether the rainwater has to be treated before being used. The ability to collect rainwater and raw water in the same water reservoir is dependent on the quality of the drinking water.
b. Using the rainfall data, Calculation of the maximum amount of rainfall that can be accommodated.

c. The rainfall intensity value is then calculated. This value is used to calculate the size of the rainwater gutter and the required storage tank.
d. Calculation of catchment area in this planning is the roof of buildings.
e. Calculation the clean water requirements. This calculation based on information from SNI 03-7065-2005 on daily net water demands per person and the number of students.
f. Estimating the capacity of a rainwater storage tank. The demand for clean water and information on rain output are used to calculate the rainwater storage tank's capacity.
g. Design Planning for pipe system. The piping system include rainwater catchment to the water storage tank. The determination of pipe dimension based on SNI 03-7065-2005.
h. Developing processes for operations and maintenance
i. Bill of quantity (BOQ) and cost budget plan (RAB) calculation. Based on design, requirements for the number and kind of rainwater harvesting system materials are collected. This preparation refers to the Basic unit price of activities (HSPK) Bogor City year 2023 and HSPK Bogor City 2022.

5. Conclusions and Recommendations

After implementing all planning techniques, conclusions and recommendations are formed. In a single, brief, straightforward line, the conclusion aims to address the study objectives. The recommendations in this plan are meant to help the Al Kahfi Integrated Islamic Boarding School find an alternative source for clean water.

CHAPTER IV

RESULT AND DISCUSSION

4.1 Sampling Location

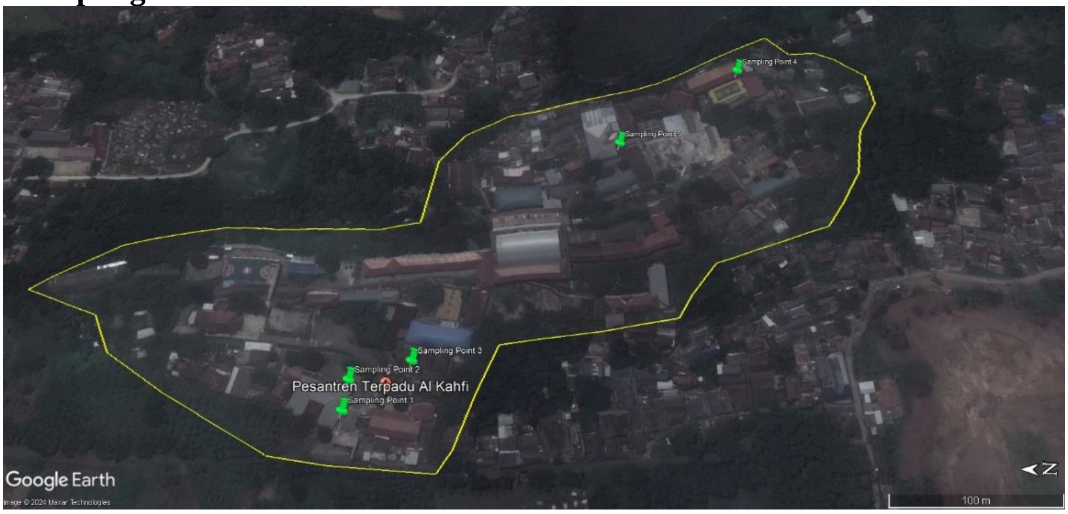


Figure 4. 1 Sampling Location Site

Figure 4. 1 above is shows the location of sampling water at Al Kahfi. The rainwater harvesting sampling locations are located at points 1, 3, 4, and 5. Sampling points 1 and 3 represent areas designated for male student, whereas sampling points 4 and 5 represent areas designated for female student. Groundwater sample was conducted at sampling point 2. The **Table 4. 1** below shows the description of sampling point and supporting documentation.

Table 4. 1 Description of Sampling Point and Documentation

No	Sample	Location	Coordinate	Documentation	
1	Rainwater sample	Male mosque	6°44'41.59"S 106°49'11.67"E		
2	Groundwater sample	Water taps near mosque	6°44'41.65"S 106°49'12.28"E		
3	Rainwater sample	Male dormitory	6°44'42.85"S 106°49'12.71"E		
4	Rainwater sample	Female dormitory	6°44'49.85"S 106°49'19.96"E		
5	Rainwater sample	Female mosque	6°44'47.10"S 106°49'18.06"E		

4.2 Rainwater Quality Analysis

A study was conducted to assess the suitability of rainwater as an alternative for potable water supply for students at the Al Kahfi Islamic Boarding School. Rainwater is required to meet Republic of Indonesia Minister of Health Regulation No. 2 of 2023's drinking water quality requirements as an alternative source of water. The suitability of groundwater for fulfilling the water consumption requirements of Islamic boarding schools is also determined through water testing. Afterwards, this information can be used to determine whether harvested rainwater can be stored in a same reservoir.

The rainwater used for the test was collected from mosques and several dorms at Islamic boarding schools that had gutters running with rainfall. The following parameters were tested: pH, nitrite, chromium, Fe, Mn, Pb, F, and Al; *E. Coli*; total coliform; temperature; TDS; turbidity; colours. These are results of the tests conducted in the laboratory. Water samples are collected at five different locations: first point is taking the rainwater sample at the male mosque, second point is taking groundwater samples, third point is taking rainwater sample at the male dormitory, fourth is taking rainwater sample at the female dormitory, and the last sample point is taking rainwater sample at the female Mosque. The laboratory test results from each sample point can be seen in the **Table 4. 2** below.

Table 4. 2 Results of the Rainwater and Ground water Quality Test

Parameter	Unit	Quality Standard	Sampling Point 1	Sampling Point 2	Sampling Point 3	Sampling Point 4	Sampling Point 5
E. Coli	CFU/100ml	0	79	2.5	45	5	8
Total Coliform	CFU/100 ml	0	103.5	37.5	18.5	23.5	38.5
Temperature	^{0}C	Air Temperature ±3	25,6	25.75	25,2	26.15	25,75
TDS	mg/L	<300	16.5	147	44	27	17
Turbidity	NTU	<3	0.55	0.485	3.24	2	1.135
Colour	TCU	10	0.25	0.25	83	0.35	1,35
pH	-	6.5 – 8.5	5.7	7	6.3	7.425	7.58
Nitrite	mg/L	3	0.0575	<0.005	0,0145	0.07	0.03
Chromium	mg/L	0.01	<0.01	0.01	0.05	<0.01	<0.01
Iron	mg/L	0.2	<0.03	0.02	0.065	0.02	0.055
Manganese	mg/L	0.1	<0.01	0.015	0.29	<0.01	<0.01
Lead	mg/L	0.01	<0.01	<0.01	0.01	0.01	0.01
Fluoride	mg/L	1.5	0.25	0.135	0.07	0.06	0.155
Aluminium	mg/L	0.2	0.065	0.045	0.05	0.06	0.07

The yellow colours are indicating that the parameter exceeds the quality standard. The laboratory testing conducted at the Regional Health Laboratory of Bogor Regency and Bogor City yielded the findings on the quality of rainwater and groundwater. The laboratory test results are available in **Appendix I**. Testing was conducted for two days at each sample point. The table displays the average values of laboratory test results over a period of two days. Based on rainwater and groundwater testing results, the total coliform and *E. Coli* parameters are still falling below of drinking water quality regulations, the basic water treatment unit is required to lower these values. At the sampling location in the male dormitory, rainwater testing results did not meet drinking water quality criteria for turbidity, colour, pH, chromium, and manganese. The quality of rainwater may be affected by a wide range of factors, such as the quantity of rainfall, nearby industrial operations, local geology, roof conditions, and household plumbing systems. The existing condition of the water gutters in the male dormitory makes problems obvious. The **Figure 4. 2** shows the rain gutters of the male dorm in condition.

Figure 4. 2 The Rain Gutters of the Male Dorm in Condition

Unclean gutters tend to accumulate debris and particles from the air, leading to a decline in the quality of rainwater. Additionally, the presence of moss in gutters can impact the colour and pH of rainwater. To address this issue, a processing unit is required. The presence of heavy metals, such as chromium and manganese, in water can originate from several sources, including industrial, mining, and transportation activities, as well as natural processes such soil erosion and biological activity. Water contamination with heavy metals has the potential to present significant health hazards to all forms of life (newsunair, 2021). Consuming water with a low pH can harm the digestive tract, teeth, gums, and lead to stomach discomfort (Kevin et al., 2023). Consuming water that contains chromium can have carcinogenic effects on the body. Therefore, it is crucial to closely monitor the levels of chromium in drinking water (Andini, 2017). The planning for this processing unit will be covered in next Sub-chapter

4.3 Clean Water Demands in Dormitories

The water requirements for the Al Kahfi Islamic Boarding School are determined by calculating the full capacity of the dormitory, as indicated in **Table 2. 2** and **Table 2. 3**. According to Mr. Nugraha, the secretary of the Al Kahfi integrated Islamic boarding school the enrolment will stay the same every year depending on the dorm capacity. The water consumption for different types of dormitory buildings, as specified by the SNI 03-7065-2005 standard, is 120 litres per resident per day. Below is an example of how to calculate total water requirements.

Known:
Building : A (Usman Dormitory)
Occupant capacity : 60
Drinking water requirements : 0.12 m^3/cap.day
Calculation:
B = D x P
B = 0.12 m^3/cap.day x 60
B = 7.3 m^3/day = 216 m^3/month

The **Table 4. 3** and

Table 4. *4* below show the results of total water requirement for each dormitory.

Table 4. 3 Clean Water Demands in Each Male Dormitory

Building	Occupant Capacity	Clean Water Requirements (m^3/cap.day)	Total Water Requirement (m^3/day)	Total Water Requirement (m^3/month)
A	60	0.12	7.2	216
B	66		7.92	237.6
C	70		8.4	252
D	44		5.28	158.4

Building	Occupant Capacity	Clean Water Requirements (m³/cap.day)	Total Water Requirement (m³/day)	Total Water Requirement (m³/month)
E	138		16.56	496.8
F	130		15.6	468
G	92		11.04	331.2
H	82		9.84	295.2
I	66		7.92	237.6

Table 4. 4 Clean Water Demands in Each Female Dormitory

Building	Occupant Capacity	Clean Water Requirements (m³/cap.day)	Total Water Requirement (m³/day)	Total Water Requirement (m³/month)
J	186	0.12	22.32	669.6
K	66		7.92	237.6
L	90		10.8	324
M	24	0.12	2.88	86.4
N	170		20.4	612
O	160		19.2	576
P	44		5.28	158.4
Q	36		4.32	129.6
R	24		2.88	86.4
S	24		2.88	86.4
T	24		2.88	86.4
U	88		10.56	316.8
			0	0
V	38		4.56	136.8

The water requirements calculation is completed in days and months based on the units needed. Subsequently the volume of the reservoir will be calculated based on the amount of clean water each building demands. The description of the building can be seen in the **Table 2. 2** and **Table 2. 3**

4.4 Roof Area of the Dormitory Building

The rainwater harvesting system employed is roof top harvesting, demanding the calculation of the rain catchment area represented by the building roof. Each dormitory at Al Kahfi Islamic Boarding School has a varied rain catchment area as a result of the many roofs forms present, including gable roof, shield roof, overlaid hip roof, and cross gabled roof. **Figure 4. 3**, **Figure 4. 4**, **Figure 4. 5**, **Figure 4. 6**, **Figure 4. 7**, and **Figure 4. 8** are the illustrations of the shape of the building roof. Below are the calculations example of roof area.

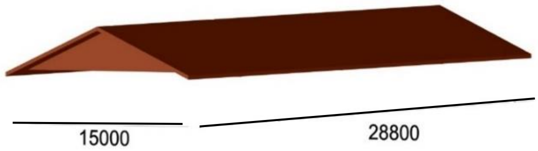


Figure 4. 3 Gable Roof Projection of Usman Dormitory (Building *A*)

<u>Known:</u>
Building : A (Usman Dormitory)
Width : 15 m
Length : 28.8 m
<u>Calculation:</u>

Roof area = L x W
Roof area = 28.8 m x 14 m
Roof area = 432 m^2

The Abu dormitory (Building C) is the next structure with an overlaid hip roof. Here is an illustration and example of the calculation.

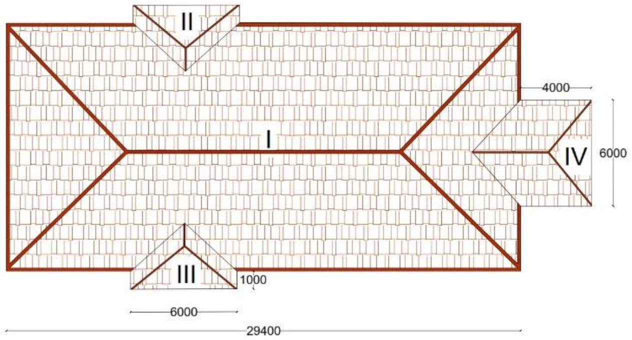


Figure 4. 4 Layout of Overlaid Hip Roof of Abu Bakar Dormitory (Building *C*)

Known:
Buidling : Abu Bakar (Building C)
Segment I
Width : 14 m
Length : 29.4 m
Segment II
Width : 1 m
Length : 6 m
Segment IV
Width : 4 m
Length : 6 m

Calculation:

Segment I
Roof area = 29.4 m x 14 m
Roof area = 411.6 m^2

Segment II and III
Roof area = 6 m x 1 m
Roof area = 6 m^2

Segment IV
Roof area = 6 m x 4 m
Roof area = 24 m^2

Total roof area = 411.6 m^2 + 24 m^2+ 6 m^2+ 6 m^2
= 517 m^2

The Arman dormitory (Building D) is the next structure with U shaped roof. Here is an illustration and example of the calculation.

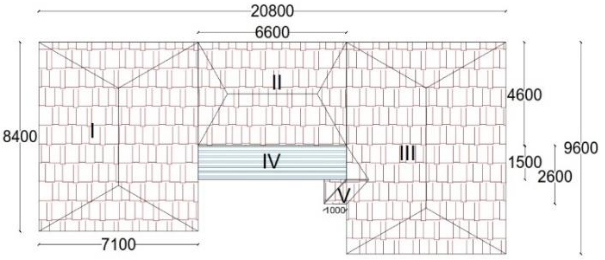


Figure 4. 5 Layout of U-Shaped Roof of Arman Dormitory (Building *D*)

The roof of the Arman dormitory features a U-shaped design, complemented with a canopy roof at the front. The calculation will be divided into five segments. The following is an example of the calculation

Known:

Buidling : Arman (Building D)

Segment I

Width : 7.1 m

Length : 8.4 m

Segment II

Width : 4.6 m

Length : 6.6 m

Segment III

Width : 7.1 m

Length : 9.2 m

Segment IV

Width : 1.5 m

Length : 6.6 m

Segment V

Width : 1 m

Length : 2.6 m

Calculation:

Segment I

Roof area = 7.1 m x 8.4 m

Roof area = 59.64 m^2

Segment II

Roof area = 6.6 m x 4.6 m

Roof area = 30.36 m^2

Segment III

Roof area = 9.2 m x 7.1 m

Roof area = 68.16 m^2

Segment IV

Roof area = 6.6 m x 1.5 m

Roof area = 9.9 m^2

Segment V

Roof area = 1 m x 2.6 m

Roof area = 2.6 m^2

Total Area = 59.64 m^2 + 30.36 m^2 + 68.16 m^2 + 9.9 m^2 + 2.6 m^2

= 170.66 m^2

The Hamzah dormitory (Building E) is the next structure with U shaped roof. Here is an illustration and example of the calculation.

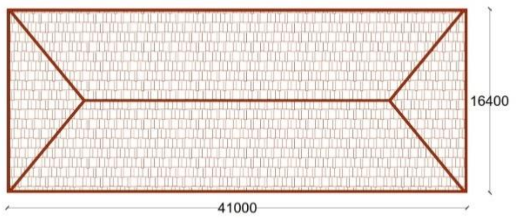


Figure 4. 6 Layout of Shield Roof of Hamzah Dormitory (Building *E*)

Known:

Building : E (Hamzah Dormitory)
Width : 16.4 m
Length : 41 m
Calculation:
Roof area =16.4 m x 41 m
Roof area = 687 m^2

The Umar dormitory (Building G) is the next structure with cross gabled roof. Here is an illustration and example of the calculation.

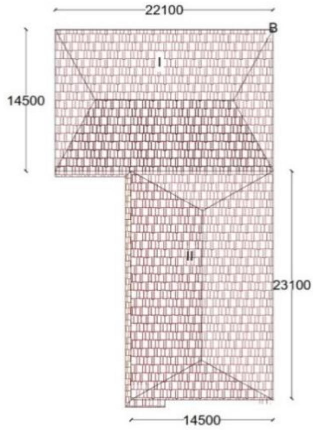


Figure 4. 7 Layout of Second Floor Roof of Umar Dormitory (Building *G*)

Known:
Building : G (Umar Dormitory)
Segment I
Width : 14.5 m
Length : 22.1 m
Segment II
Width : 14.5 m
Length : 23.1 m
Calculation:
Segment I
Roof area = 14.5 m x 22.1 m
Roof area = 320.45 m^2
Segment II
Roof area = 14.5 m x 23.1 m
Roof area = 334.95 m^2
Total Area = 320.45 m^2 +334.95 m^2
= 665.4 m^2

The Khonsa (Building N) is the next structure with two type of roofs shield roof and flat roof. Here is an illustration and example of the calculation.

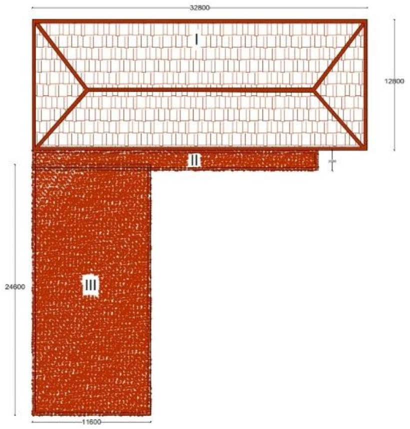


Figure 4. 8 Layout of Khonsa Dormitory (Building *N*)

<u>Known:</u>
Buidling : Khonsa (Building N)
Segment I
Width : 12.8 m
Length : 32.8 m
Segment II
Width : 2 m
Length : 28 m
Segment III
Width : 11.6 m
Length : 24.6 m
<u>Calculation:</u>
Segment I
Roof area = 32.8 m x 12.8 m
Roof area = 419.84 m^2
Segment II
Roof area = 28 m x 2 m
Roof area = 56 m^2
Segment III
Roof area = 24.6 m x 11.6 m
Roof area = 290.3 m^2

Total roof area = 419.84 m^2+ 56 m^2+ 355 m^2
= 766 m^2

The calculation method for obtaining the total roof area involves applying the same procedure to several roofs of the same type. The **Table 4. 5** is shows the results of the roof area.

Table 4. 5 Roof Surface Area of Each Building at Al Kahfi Islamic Boarding School

Block	Building	Roof Shape	Surface Area (m^2)
Male Area	A	Gable	432
	B	Gable	371
	C	Overlaid Hip	448
	D	U-Shaped	170.66
	E	Shield	687
	F	Flat	

Block	Building	Roof Shape	Surface Area (m²)
	G	Cross Gabled Roof	665.4
	G'		
	H	Gable	340
	I	Shield	300
Female Area	J	Flat	
	K	Gable	279
	L	Shield	340
	M	Gable	135
	N	Shield and Flat	766
	O	Gable	704
	O'		
	P	Gable	225
	P'		
	Q	Gable	339
	R	Gable	162
	S	Gable	162
	T	Gable	186
	U	Flat	
	V	Gable	155

The roofs of buildings F, J, and U are utilized for public facilities including fields and mosques at an Islamic boarding school. Consequently, it is not feasible to install rainwater harvesting systems in these buildings.

4.5 Rainfall Analysis

The rainfall data was acquired from the BMKG station located in Citeko Village, Cisarua District, Bogor Regency. The estimations are based only from one station due to the limited operational history of the nearby rain gauge, resulting in insufficient data availability. The planning considers the rainfall data from 2014 to 2023, covering a period of 10 years. After analyzing rainfall data from the last decade, it was determined that the maximum amount of rainfall was recorded in January 2014. Therefore, this particular month was selected for the purpose of designing rainwater storage systems. **Figure 4. 9** is shows the fluctuations of the rainfall over ten years start from 2014 until 2023.

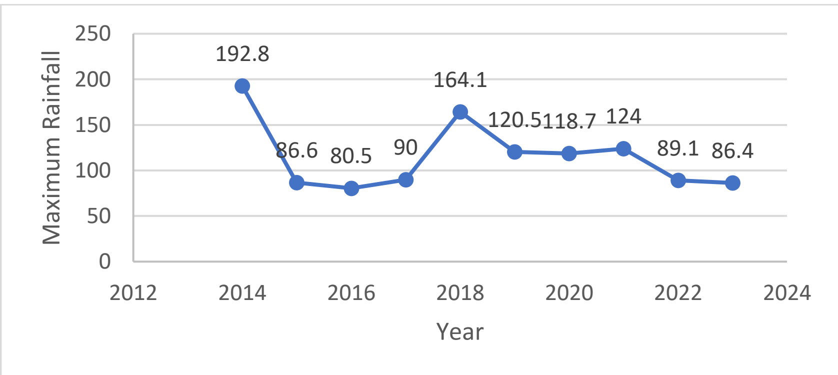


Figure 4. 9 Graph of Maximum Rainfall Fluctuations for a Decade

Rainfall data for the past decade can be seen in the **Appendix II**. **Table 4. 6** Below is the rainfall data for the month of January in the year 2014.

Table 4. 6 the rainfall data for the month of January 2014.

Date	Rainfall (mm)	Date	Rainfall (mm)
1	6	**17**	0
2	2.2	**18**	140.6
3	21.6	**19**	74.8
4	0	**20**	16.5
5	5	**21**	78.9
6	1.6	**22**	78.3
7	0	**23**	48.8
8	1.2	**24**	54.6
9	6	**25**	25
10	0	**26**	1.6
11	23.9	**27**	17.3
12	64.6	**28**	0
13	132.5	**29**	52.3
14	13.4	**30**	192.8
15	37.3	**31**	23.3
16	13.9		

4.6 Rainwater Harvesting System Period

There are two options available for rainwater harvesting: either delivering clean water for a duration of 1 year or only during the rainy season. Different factors that have an impact include variations in water demand and rainwater supply, the required reservoir capacity, and the availability of land. **Table 4. 7** is an example of a calculation using rainfall data from 2014 and the area of usman building to demonstrate the maximum capacity for accommodating rain.

Table 4. 7 Reservoir Capacity for One Year

Month	Rainfall (mm)	Vol Supply (m^3)	Supply Accumulation (m^3)	Vol Usage (m^3)	Usage Accumulation(m^3)	Difference
1	1134	392.00	392.00	216	216	176.00
2	623.8	216.00	608.00	216	432	176.00
3	266.7	93.00	701.00	216	648	53.00
4	403.8	140.00	841.00	216	864	-23.00
5	219.9	76.00	917.00	216	1080	-163.00
6	199.1	69.00	986.00	216	1296	-310.00
7	344.1	119.00	1105.00	216	1512	-407.00
8	249.8	87.00	1192.00	216	1728	-536.00
9	33.6	12.00	1204.00	216	1944	-740.00
10	94.2	33.00	1237.00	216	2160	-923.00
11	548.3	190.00	1427.00	216	2376	-949.00
12	445.7	155.00	1582.00	216	2592	-1010.00
Maximum						176.00
Minimum						1010
Volume of Reservoir (m^3/year)						1186
Volume of Reservoir (L/year)						1,186.000

These quantities are excessively large and difficult to implement at the Al-Kahfi Islamic Boarding School, hence rainwater is only utilized during the period of rainfall. The dormitory of the Al Kahfi Islamic Boarding School continues to rely on groundwater as its primary water source, while the rainwater collection system serves as a secondary option specifically for drinking water.

4.7 Estimation of Potential Rainfall and Rainwater Storage

4.7.1 Potential Rainfall

Potential rainfall refers to the projected amount of rainfall that can be harvested. The selected month for the calculation is January 2014, as it had the greatest amount of rainfall in a decade. Here is an example of how to calculate potential rainfall.

Potential Rainfall on January 1st, 2014
Rainfall = 6 mm/day
Roof area Building A = 432 m^2
Runoff coefficient = 0.8 (It is assumed that the remaining water either evaporates or is lost due to other possibilities)
Volume of potential rainfall = $432 \times \frac{6}{1000} \times 0.8$
= 3 m^3

The potential rainfall volume, also known as water supply, is decreased by the water demand to determine the volume of the rainwater storage tank. Here is an example of the calculation.

Supply Volume on January 1st, 2014, = 3 m^3
Water Usage Building A = 7.2 m^3
V = S-B
V = 3 m^3 - 7.2 m^3
= - 4 m^3

The volume of the storage tank for each Islamic boarding school dormitory building is then estimated for each day for 1 month. The cumulative volume of rainwater supply and the accumulated volume of daily water usage are estimated as well and the difference between the two is calculated to give the monthly and daily volume of rainwater storage tanks. Below are results of calculating the volume of rainwater storage tanks for building A (Usman dormitory)

Table 4. 8 Rainwater Storage Volume Building A

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
1	6	432	3	3	7.2	7.2	-4
2	2.2	432	1	4	7.2	14.4	-10
3	21.6	432	8	12	7.2	21.6	-10
4	0	432	0	12	7.2	28.8	-17
5	5	432	2	14	7.2	36.0	-22
6	1.6	432	1	15	7.2	43.2	-28
7	0	432	0	15	7.2	50.4	-35
8	1.2	432	1	16	7.2	57.6	-42
9	6	432	3	19	7.2	64.8	-46
10	0	432	0	19	7.2	72.0	-53
11	23.9	432	9	28	7.2	79.2	-51
12	64.6	432	23	51	7.2	86.4	-35
13	132.5	432	46	97	7.2	93.6	3
14	13.4	432	5	102	7.2	100.8	1
15	37.3	432	13	115	7.2	108.0	7
16	13.9	432	5	120	7.2	115.2	5

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
17	0	432	0	120	7.2	122.4	-2
18	140.6	432	49	169	7.2	129.6	39
19	74.8	432	26	195	7.2	136.8	58
20	16.5	432	6	201	7.2	144.0	57
21	78.9	432	28	229	7.2	151.2	78
22	78.3	432	28	257	7.2	158.4	99
23	48.8	432	17	274	7.2	165.6	108
24	54.6	432	19	293	7.2	172.8	120
25	25	432	9	302	7.2	180.0	122
26	1.6	432	1	303	7.2	187.2	116
27	17.3	432	6	309	7.2	194.4	115
28	0	432	0	309	7.2	201.6	107
29	52.3	432	19	328	7.2	208.8	119
30	192.8	432	67	395	7.2	216.0	179
31	23.3	432	9	404	7.2	223.2	181
Max							181
Min							53
Volume of Reservoir (m³/month)							234
Volume of Reservoir (m³/day)							8

The calculation results for more buildings may be found in **Appendix III**. Below are the graphs show the comparison of water supply and water usage for each building.

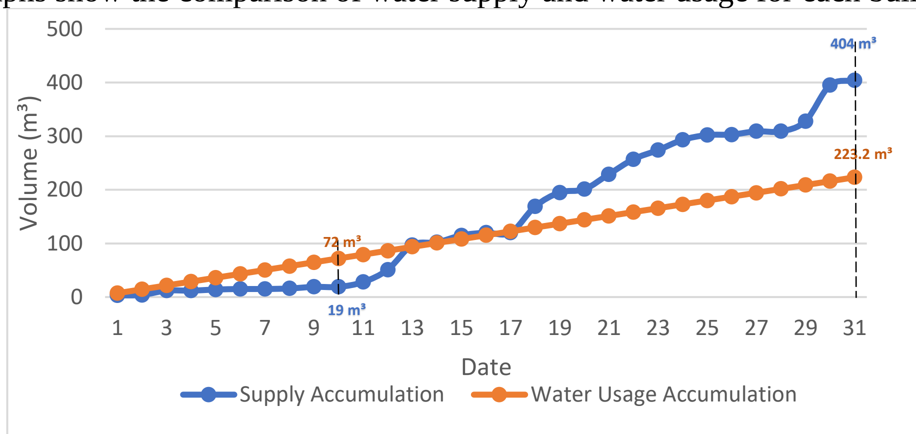


Figure 4. 10 Graph of Comparison of Water Supply and Usage at Building A

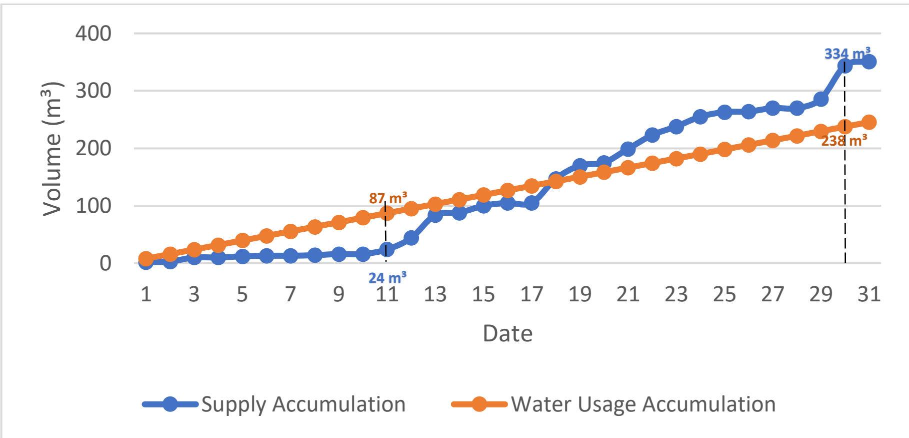


Figure 4. 11 Graph of Comparison of Water Supply and Usage at Building B

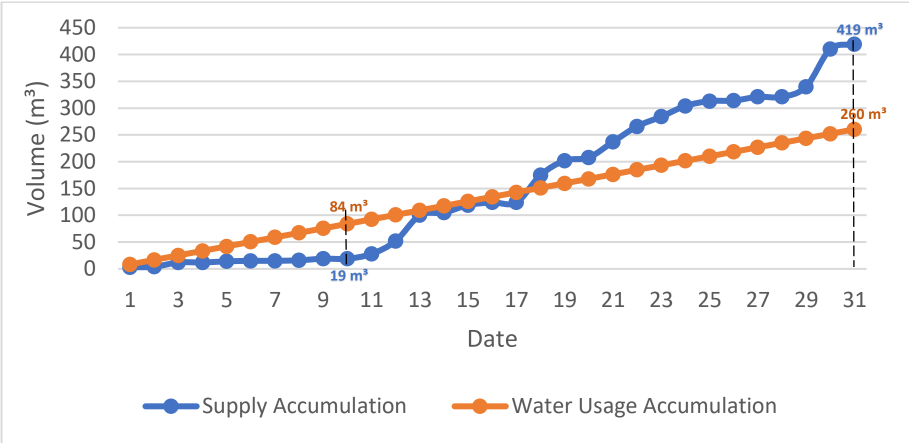


Figure 4. 12 Graph of Comparison of Water Supply and Usage at Building C

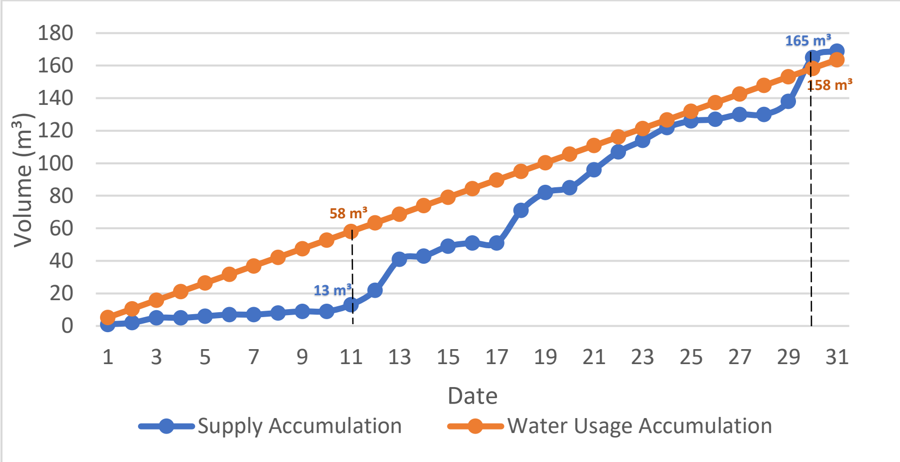


Figure 4. 13 Graph of Comparison of Water Supply and Usage at Building D

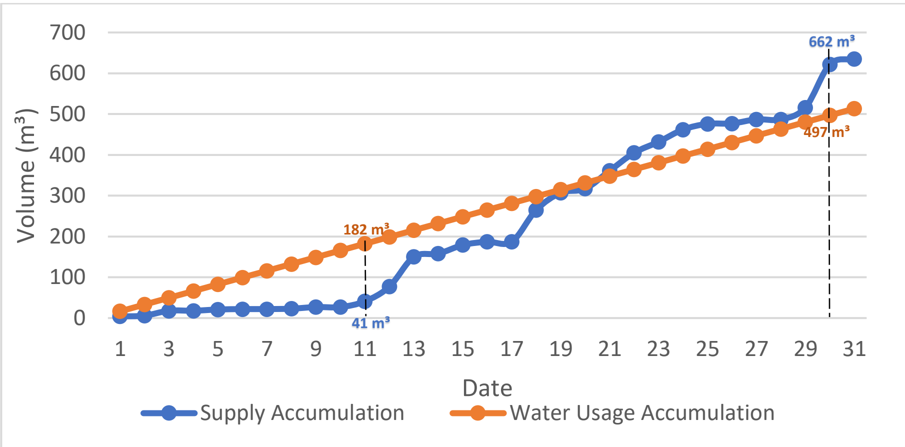


Figure 4. 14 Graph of Comparison of Water Supply and Usage at Building E

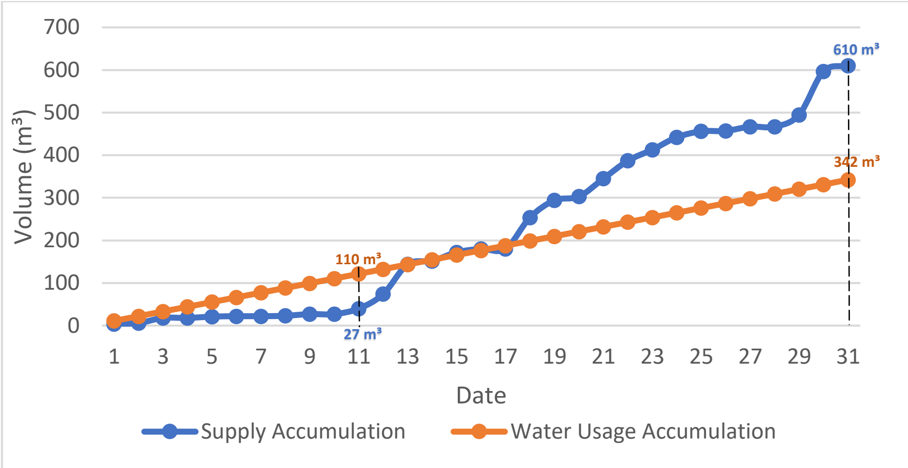


Figure 4. 15 Graph of Comparison of Water Supply and Usage at Building G

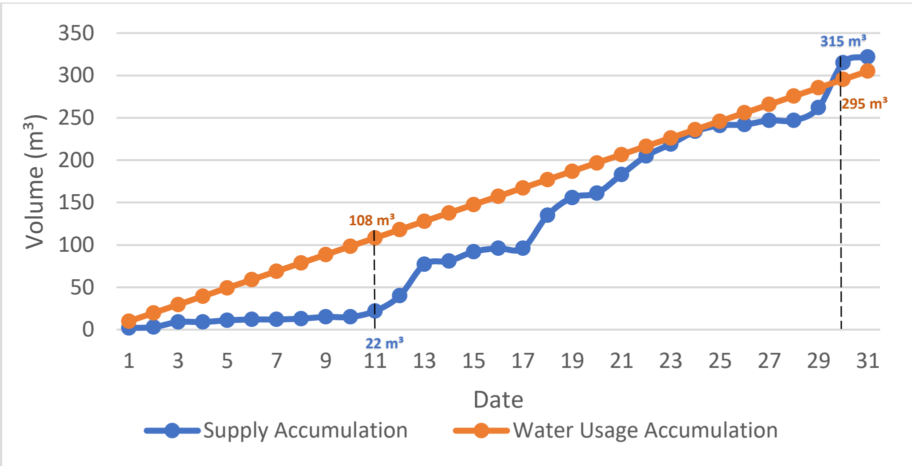


Figure 4. 16 Graph of Comparison of Water Supply and Usage at Building H

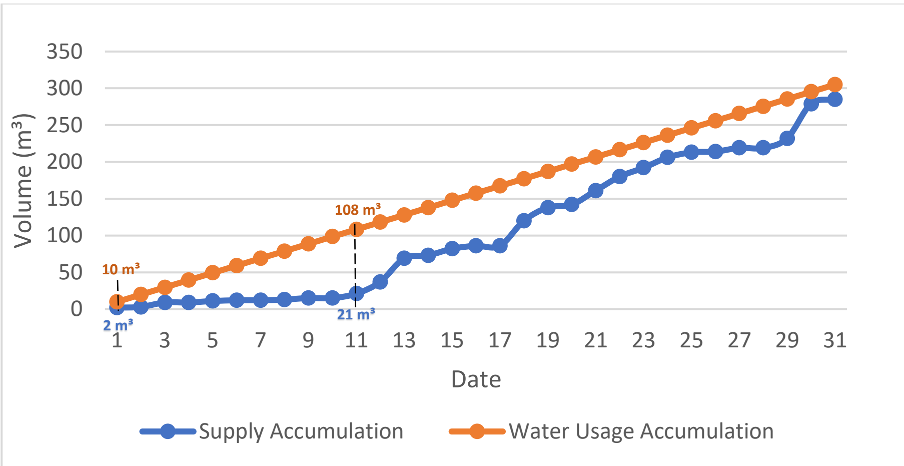


Figure 4. 17 Graph of Comparison of Water Supply and Usage at Building I

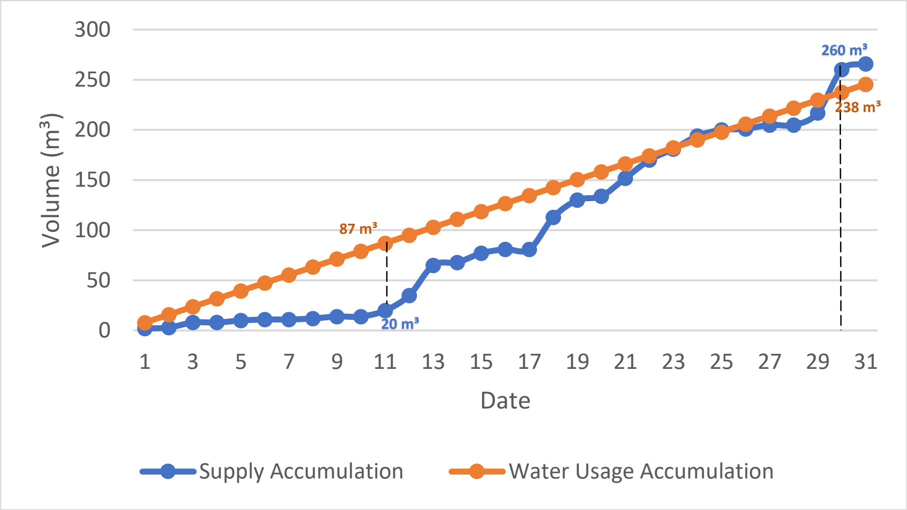


Figure 4. 18 Graph of Comparison of Water Supply and Usage at Building K

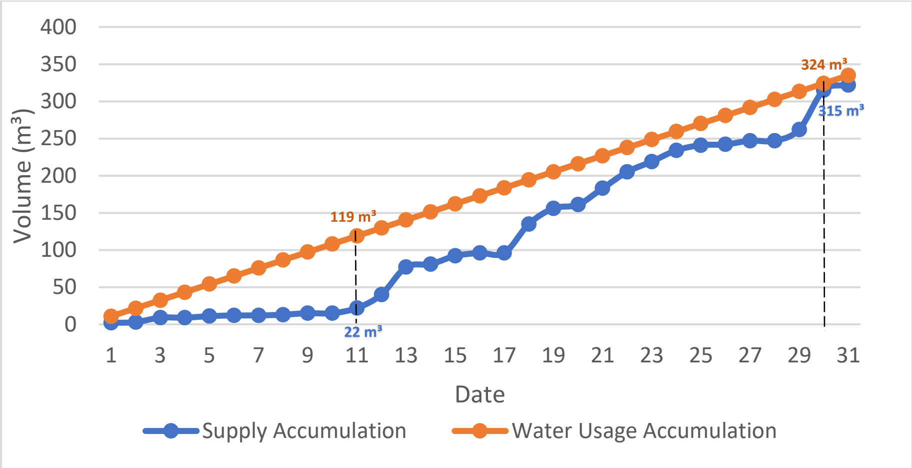


Figure 4. 19 Graph of Comparison of Water Supply and Usage at Building L

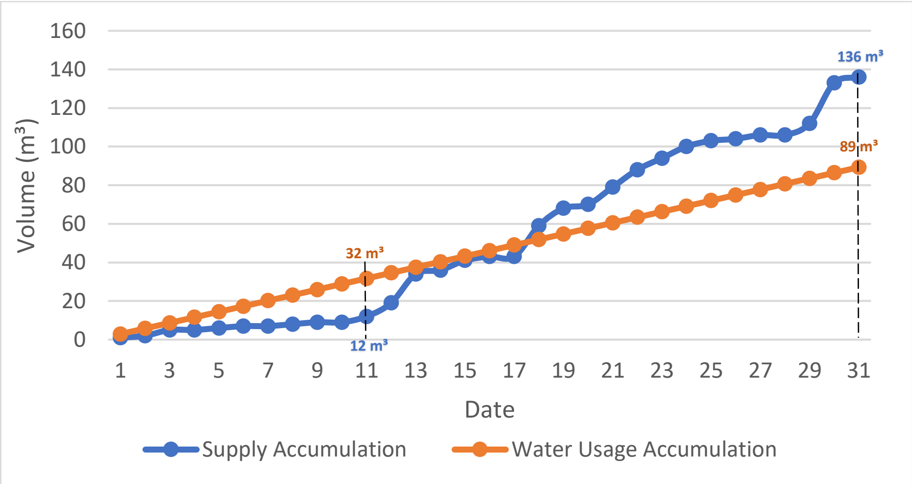


Figure 4. 20 Graph of Comparison of Water Supply and Usage at Building M

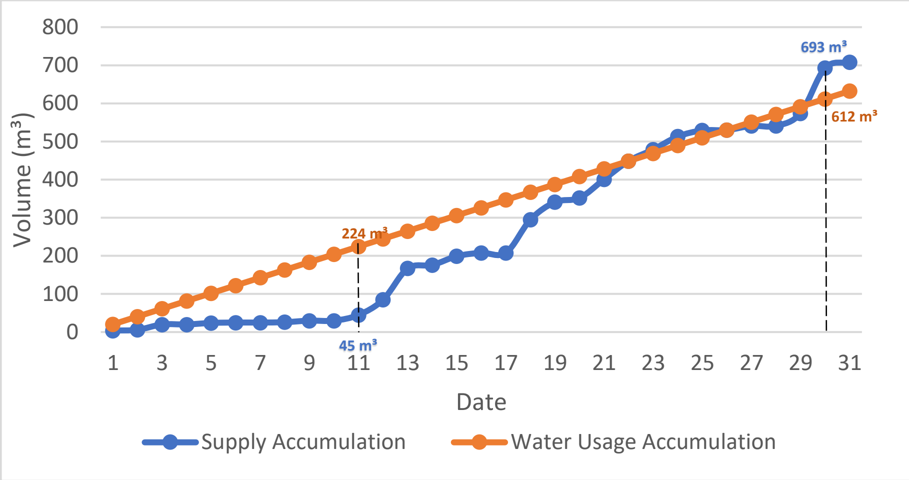


Figure 4. 21 Graph of Comparison of Water Supply and Usage at Building N

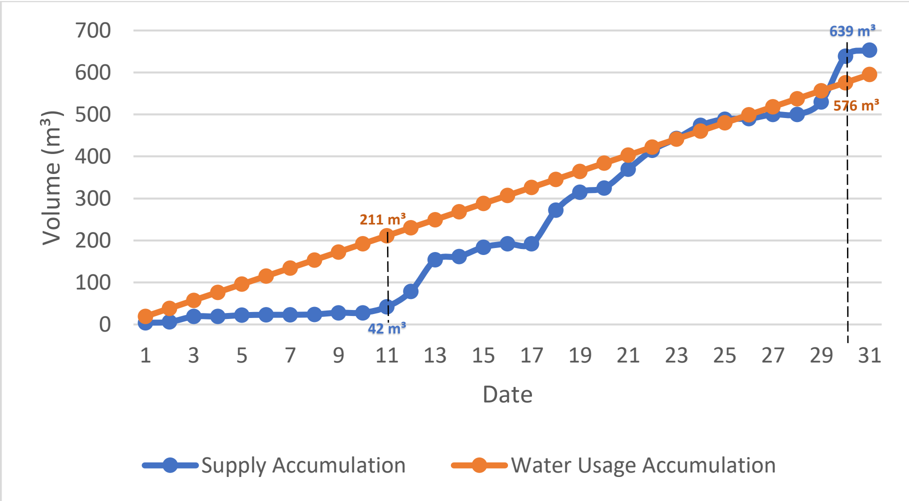


Figure 4. 22 Graph of Comparison of Water Supply and Usage at Building O

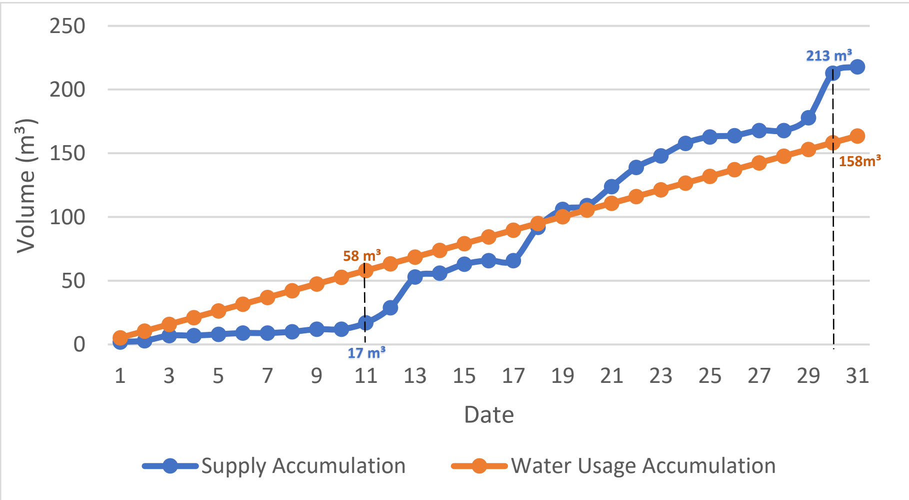


Figure 4. 23 Graph of Comparison of Water Supply and Usage at Building P

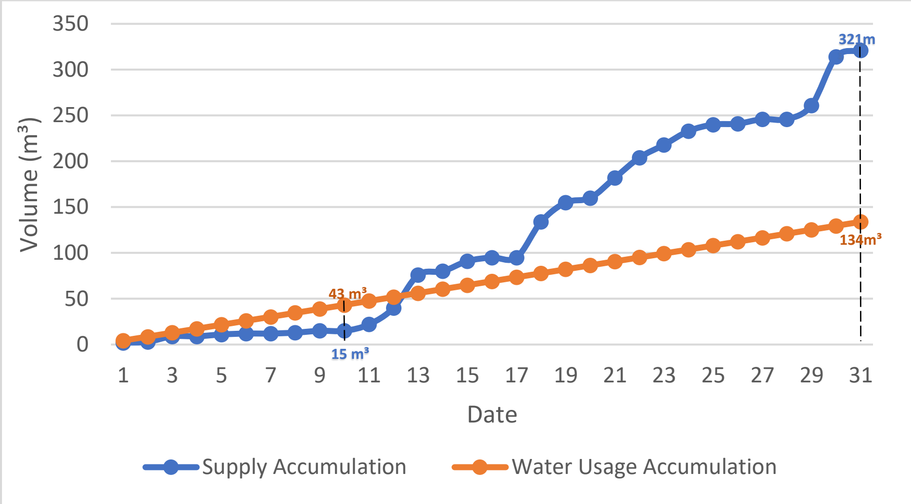


Figure 4. 24 Graph of Comparison of Water Supply and Usage at Building Q

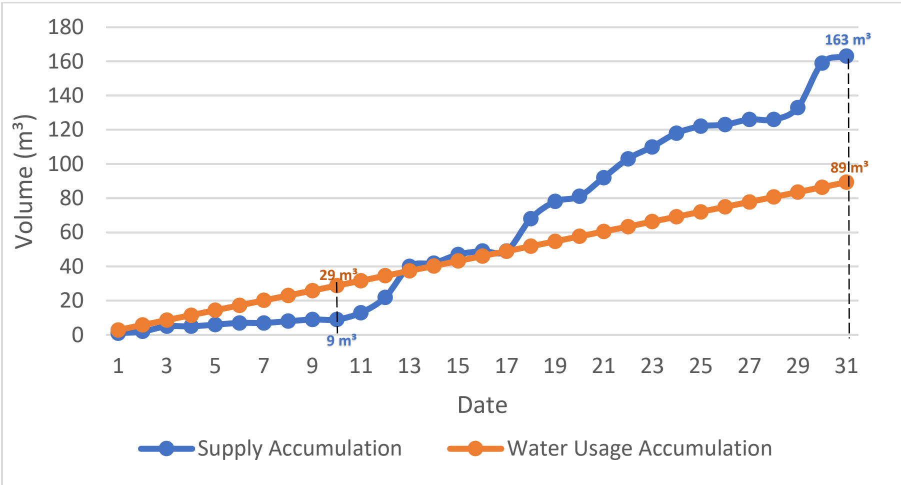


Figure 4. 25 Graph of Comparison of Water Supply and Usage at Building R and S

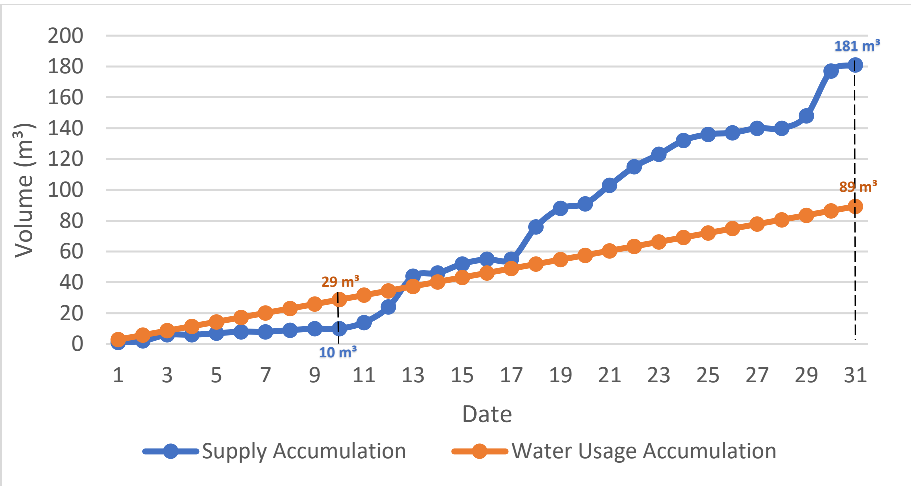


Figure 4. 26 Graph of Comparison of Water Supply and Usage at Building T

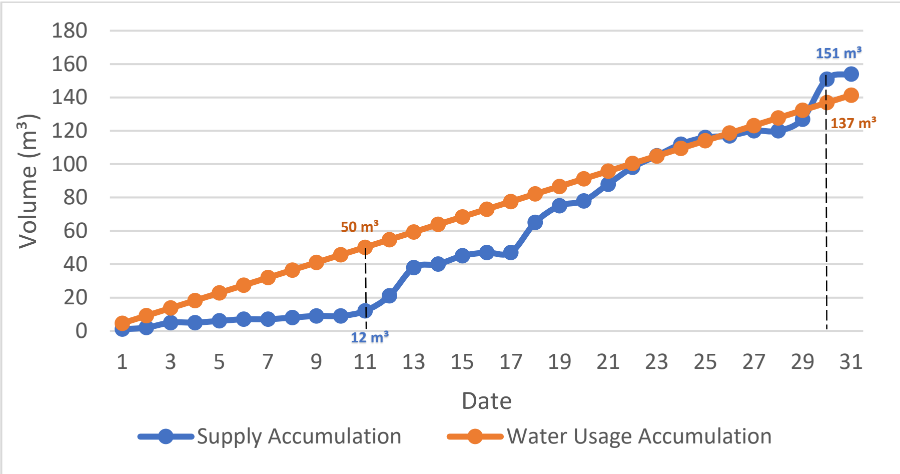


Figure 4. 27 Graph of Comparison of Water Supply and Usage at Building V

Based on the graph from **Figure 4. 10** until **Figure 4. 27**, it is evident that rainwater can serve as an effective way to decrease dependence on groundwater. The rainfall collected is insufficient to entirely satisfy the clean water requirements of each dormitory. Consequently, groundwater is still utilised, with rainwater serving as an additional water source only during the rainy season.

4.7.2 Rainwater Storage

The rainfall calculation uses daily rainwater harvesting as it considers factors such as land availability, fluctuations in rainfall throughout the year, and variations in the demand for clean water, particularly during periods when students are on break and not present at the dormitory. The reservoir is designed with a safety factor of 1.2, allowing for potential measurement uncertainty and variations in the environment. In static load settings, a safety factor of 1.2 is commonly used when load conditions can be correctly predicted. It is generally accepted that this safety factor is sufficient to ensure the structure operates as intended (Libratama.Com, n.d.). The following table provides the daily reservoir volume data. **Table 4. 9** is shows the volume of the reservoir for each building.

Table 4. 9 Reservoir Volume for each Islamic Boarding School Dormitory Building

Block	Building	Volume of Reservoir (m^3/day)	Safety Factor	Volume of Reservoir (m^3/day)
Male Area	A	8	1.2	9.6
	B	6		8
	C	8		10
	D	2		3
	E	9		11
	G	13		15
	H	6		8
	I	4		5
Female Area	K	3	1.2	4
	L	3		4
	M	3		4
	N	9		11
	O	8		10
	P	4		5

Block	Building	Volume of Reservoir (m^3/day)	Safety Factor	Volume of Reservoir (m^3/day)
	Q	8		10
	R	4		5
	S	4		5
	T	4		5
	V	2		3

The reservoir that will be used for the reservoir has a proposed depth of two metres. Here is an example of how to calculate the dimensions of a reservoir.

<u>Known:</u>

Building : A (Usman Dormitory)
Reservoir volume : 1 m3/day
Depth : 2 m

<u>Calculation:</u>

Area = V/H

$= \frac{10}{2}$

$= 5\ m^2$

Then, the dimensions of reservoir are planned 3 m x 2 m

In the same way, the dimensions of reservoir for each building are calculated and the results can be seen in the **Table 4. 10** below.

Table 4. 10 Reservoir Dimensions of each Building

Block	Building	Volume of Reservoir (m^3/day)	Volume of Reservoir (m^3/day)	Depth (m)	Area (m^2)	Dimensions	
						Length (m)	Width (m)
Male Area	A	8.0	9.6	2	4.8	2.2	2.2
	B	6.0	8	2	4	2	2
	C	8.0	10	2	5	2.24	2.24
	D	2.0	3	2	1.5	1.5	1
	E	9.0	11	2	5.5	2.35	2.35
	G	11.71	15	2	7.5	4	2
	H	6.0	8	2	4	2	2
	I	4.0	5	2	2.5	1.58	1.58
Female Area	K	3	4	2	2	2	1
	L	3	4	2	2	2	1
	M	3	4	2	2	2	1
	N	9	11	2	5.5	2.35	2.35
	O	8	10	2	5	2.24	2.24
	P	4	5	2	2.5	2.5	1
	Q	8	10	2	5	2.24	2.24
	R	4	5	2	2.5	2.50	1.00
	S	4	5	2	2.5	2.50	1.00
	T	4	5	2	2.5	2.5	1
	V	2	3	2	1.5	1.5	1

The reservoir that is used in this case is a reservoir tank that available in the market with appropriate volume. The reservoir tank is used because it allows easier cleaning.

4.8 Water Savings

The amount of rainfall fluctuates on every day. Rainfall impacts the quantity of collected rainwater, which can serve as an alternate source of drinking water. The subsequent information provides an estimate of the monthly reduction in groundwater usage at the Al Kahfi Islamic Boarding School. The average monthly rainfall is determined by analyzing the data from rain stations over a period of 10 years. The following are the example of the calculation of water savings in January for Usman dormitory (A building)

<u>Known:</u>

Average Rainfall : 376.71 mm/month
Roof Area : 432 m^2
Demand : 216 m^3/month

<u>Calculation:</u>

Supply $= \frac{376.71}{1000} \times 432 \times 0.8 = 131\ m^3/month$

Water Savings $= \frac{Supply}{Demand} \times 100 = \frac{131\ m^3/month}{216\ m^3/month} \times 100$
$= 61\%$

Subsequently, the monthly water conservation for the entire building is calculated. The graph in the **Figure 4. 28** until **Figure 4. 39** depicts the calculated water savings for each building over a one-month period.

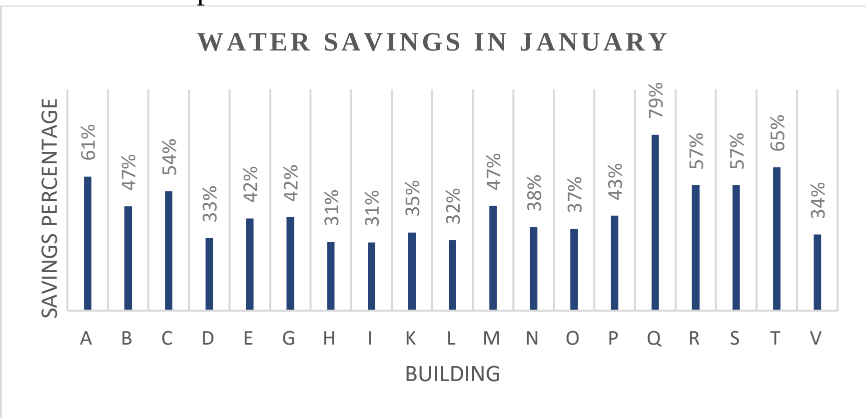


Figure 4. 28 Graph of Groundwater Conservation Presentation in January

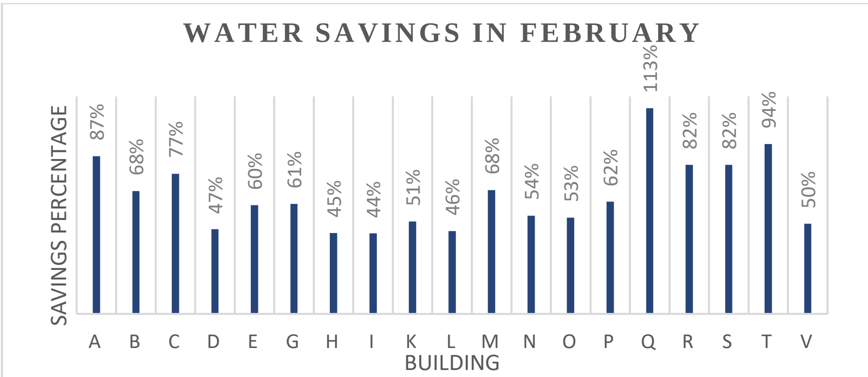


Figure 4. 29 Graph of Groundwater Conservation Presentation in February

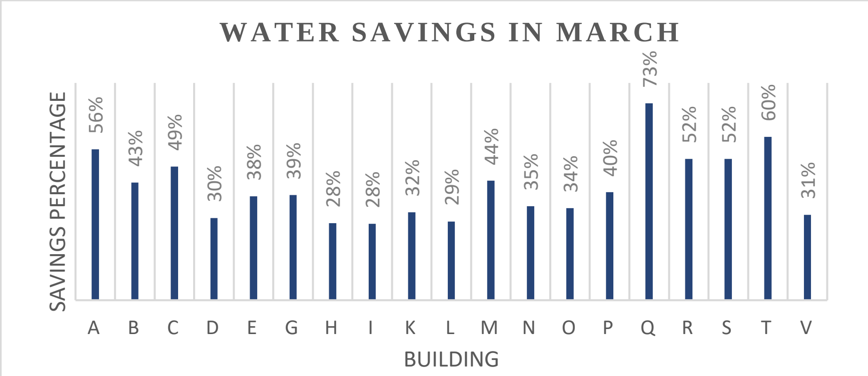


Figure 4. 30 Graph of Groundwater Conservation Presentation in March

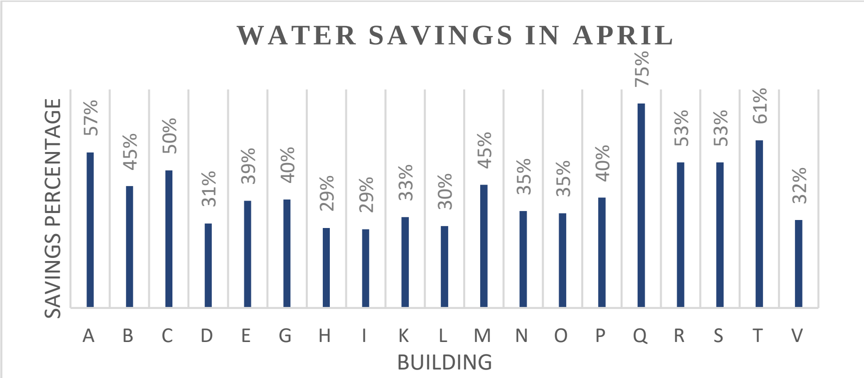


Figure 4. 31 Graph of Groundwater Conservation Presentation in April

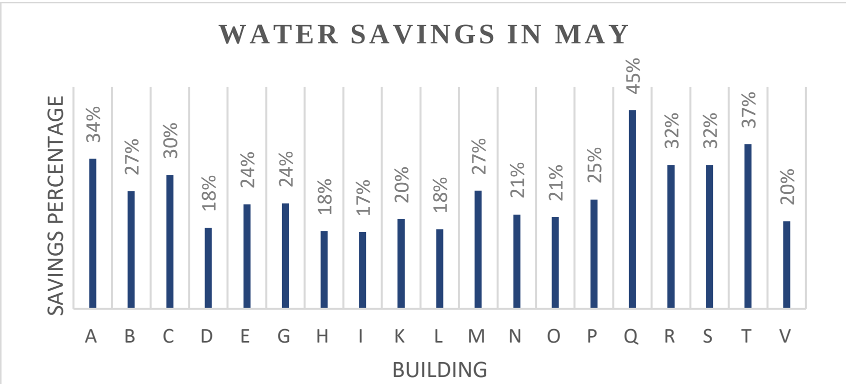


Figure 4. 32 Graph of Groundwater Conservation Presentation in May

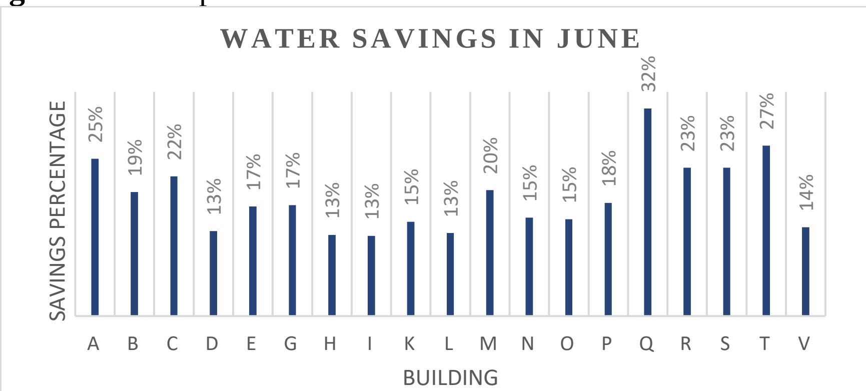


Figure 4. 33 Graph of Groundwater Conservation Presentation in June

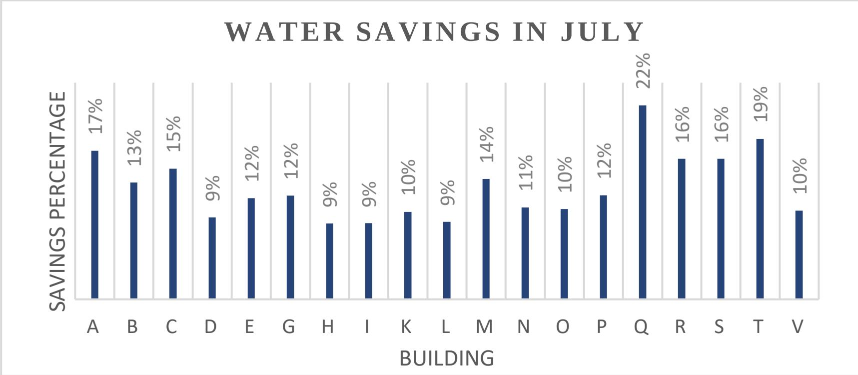


Figure 4. 34 Graph of Groundwater Conservation Presentation in July

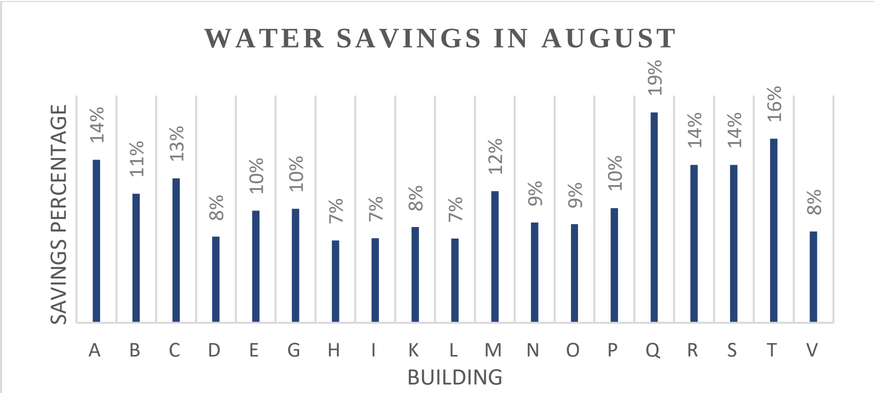


Figure 4. 35 Graph of Groundwater Conservation Presentation in August

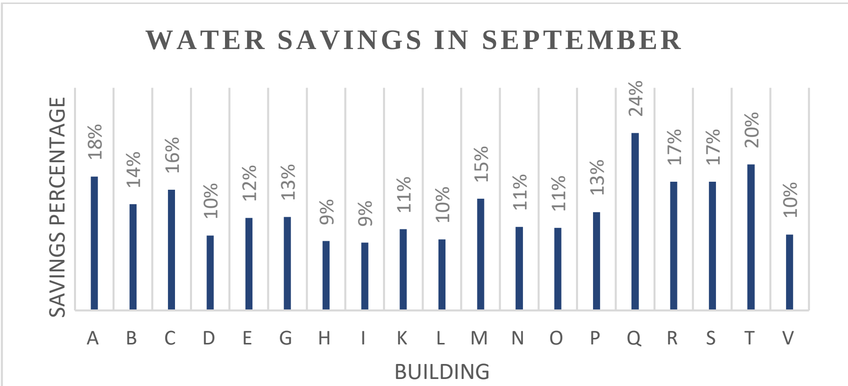


Figure 4. 36 Graph of Groundwater Conservation Presentation in September

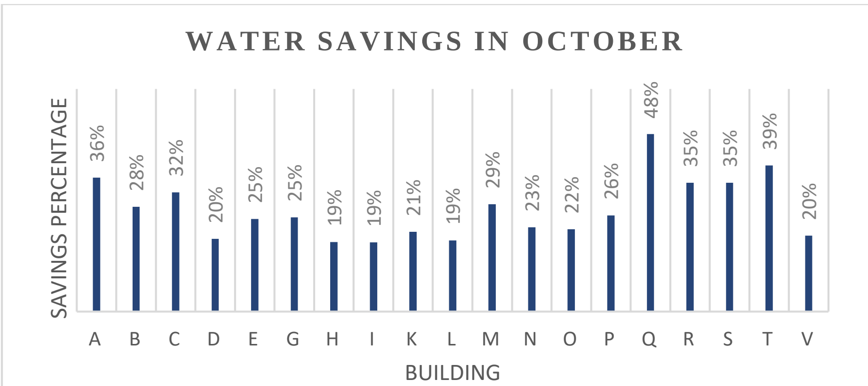


Figure 4. 37 Graph of Groundwater Conservation Presentation in October

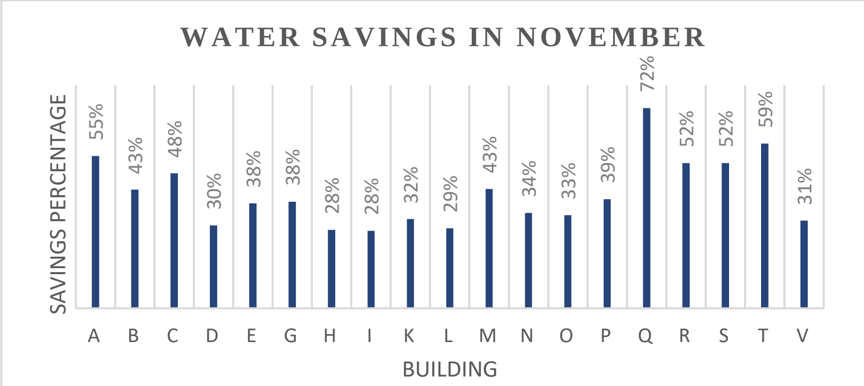


Figure 4. 38 Graph of Groundwater Conservation Presentation in November

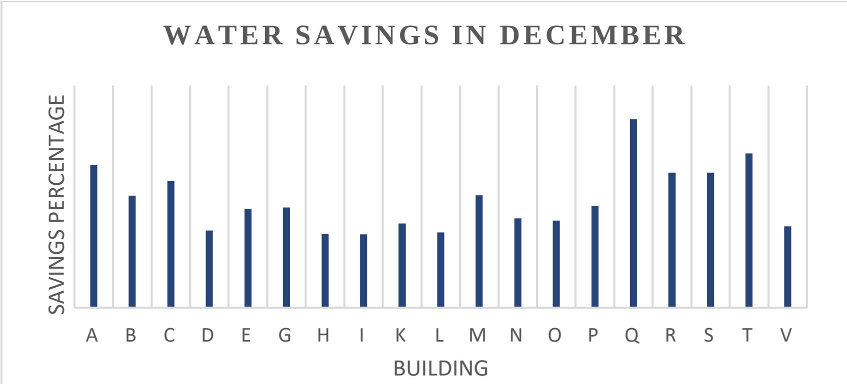


Figure 4. 39 Graph of Groundwater Conservation Presentation in December

4.9 Gutter and Piping System Planning

The planning of water gutters adheres to the guidelines provided in the SNI 03-7065-2005, which considers the size of the roof area and the intensity of rainfall. Before designing the rain gutters and piping system, it is essential to determine the rainfall intensity to estimate the amount of load that will be handled by the gutters and piping system.

4.9.1 Maximum Daily Rainfall

Rain intensity calculations require the maximum amount of rainfall. The Gumbel method is used to calculate the maximum rainfall. **Table 4. 11** below is a breakdown of the calculation step.

Table 4. 11 Rainfall Data Ranking

Year	**Maximum Daily Rainfall (mm)**	**(Ri-R)**	**(Ri-R) ²**
2014	192.8	77.53	6010.9
2018	164.1	48.83	2384.37
2021	124	8.73	76.2129
2019	120.5	5.23	27.3529
2020	118.7	3.43	11.7649
2017	90	-25.27	638.573
2022	89.1	-26.17	684.869
2015	86.6	-28.67	821.969
2023	86.4	-28.87	833.477
2016	80.5	-34.77	1208.95
Total	**1152.7**	**-1.1369E-13**	**12698.4**
Average	**115.27**		

1. Standard Deviation (σR) $= [\frac{\Sigma(Ri-R)^2}{n-1}]^{\frac{1}{2}}$

   $= [\frac{12,698.4}{10-1}]^{\frac{1}{2}}$

   $= 37.562$

TABLE –1 – REDUCED MEAN $\bar{y}_n$ IN GUMBEL'S EXTREME VALUE DISTRIBUTION

N = sample size

N	0	1	2	3	4	5	6	7	8	9
10	0.4952	0.4996	0.5035	0.5070	0.5100	0.5128	0.5157	0.5181	0.5202	0.5220
20	0.5236	0.5252	0.5268	0.5283	0.5296	0.5309	0.5320	0.5332	0.5343	0.5353
30	0.5362	0.5371	0.5380	0.5388	0.5396	0.5402	0.5410	0.5418	0.5424	0.5430
40	0.5436	0.5442	0.5448	0.5453	0.5458	0.5463	0.5468	0.5473	0.5477	0.5481
50	0.5485	0.5489	0.5493	0.5497	0.5501	0.5504	0.5508	0.5511	0.5515	0.5518
60	0.5521	0.5524	0.5527	0.5530	0.5533	0.5535	0.5538	0.5540	0.5543	0.5545
70	0.5548	0.5550	0.5552	0.5555	0.5557	0.5559	0.5561	0.5563	0.5565	0.5567
80	0.5569	0.5570	0.5572	0.5574	0.5576	0.5578	0.5580	0.5581	0.5583	0.5585
90	0.5586	0.5587	0.5589	0.5591	0.5592	0.5593	0.5595	0.5596	0.5598	0.5599
100	0.5600									

TABLE –2 – REDUCED STANDARD DEVIATION S_n IN GUMBEL'S EXTREME VALUE DISTRIBUTION

N = sample size

N	0	1	2	3	4	5	6	7	8	9
10	0.9496	0.9676	0.9833	0.9971	1.0095	1.0206	1.0316	1.0411	1.0493	1.0565
20	1.0628	1.0696	1.0754	1.0811	1.0864	1.0915	1.0961	1.1004	1.1047	1.1086
30	1.1124	1.1159	1.1193	1.1226	1.1255	1.1285	1.1313	1.1339	1.1363	1.1388
40	1.1413	1.1436	1.1458	1.1480	1.1499	1.1519	1.1538	1.1557	1.1574	1.1590
50	1.1607	1.1623	1.1638	1.1658	1.1667	1.1681	1.1696	1.1708	1.1721	1.1734
60	1.1747	1.1759	1.1770	1.1782	1.1793	1.1803	1.1814	1.1824	1.1834	1.1844
70	1.1854	1.1863	1.1873	1.1881	1.1890	1.1898	1.1906	1.1915	1.1923	1.1930
80	1.1938	1.1945	1.1953	1.1959	1.1967	1.1973	1.1980	1.1987	1.1994	1.2001
90	1.2007	1.2013	1.2020	1.2026	1.2032	1.2038	1.2044	1.2049	1.2055	1.2060
100	1.2065									

Figure 4. 40 Gumbel's Probability Table

2. **Figure 4. 40** Gumbel's Probability Table taht used to determine the reduced mean and reduced standard deviation values. Since the number of the rain data is 10, therefore the value of n is 10, the reduce mean (Yn) is 0.4952 and the reduced standard deviation (σn) is 0.9496

According to Minister of Human Settlements and Regional Infrastructure Decree No 534/KPTS/M/(2001), there are minimum service standards for spatial planning, housing and settlements, and public works. These standards include using a rain return period (PUH) of 2.5 years for managing tertiary channel planning. Thus, in order to plan rain gutters, a shorter rain return duration of 2 years is considered.

3. Reduce Variate (Yt) for rainfall return period 2 year is 0.3665
4. Next calculate the maximum daily rainfall with using equation **(6)**

   $X_{Tr} = 115.27 + \frac{(0.3665 - 0.4952)}{0.9496}$ x 37.562

   $= 110.179$
5. Calculation of confidence interval

   The confidence level is a statistically derived range of numbers that indicates the proportion of results from tests (du Prel et al., 2009).

Table 4. 12 Confidence Level

α	t (a)
50%	0.674
60%	0.841

α	t (a)
70%	1.036
80%	1.282
90%	1.645

A level of confidence of 90% was chosen to avoid error results. A statistical calculator or table with a normal distribution can be used to find the confidence level value t(a). **Table 4. 12** shows the t(a) value, at 90% confidence level, is 1.645, indicating that 90% of the normal curve's area falls between -1.645 and + 1.645.

6. Calculating k value

$k = \frac{Yt-Yn}{\sigma n}$

$k = \frac{0.3665-0.4952}{0.9496}$

$k = -1.022$

7. Calculating b value

$b = (1+1.3K+1.1K^2)^{0.5}$

$b = (1+1.3(-1.022)+1.1(-1.022)^2)^{0.5}$

$b = 0.906$

8. Calculating Standard error (Se)

$Se = b \times \frac{\sigma R}{\sqrt{n}}$

$= 0.906 \times \frac{37.562}{\sqrt{10}}$

$= 10.762$

9. Calculating the confidence interval (Rk)

$Rk = \pm t(a) \times Se$

$Rk = +1.645 \times 10.762 = 17.70$

$Rk = -1.645 \times 10.762 = -17.70$

Thus, the maximum daily rainfall value can be calculated by the following equation
Maximum Daily Rainfall = Rt ± Rk

Table 4. 13 Calculation Result of Maximum Daily Rainfall Value Gumbel Method

DRP (year)	Xtr (mm)	Maximum Daily Rainfall	
		Rt (+)	Rt (-)
2	110.179	127.883	92.475

The gumbel calculation results in **Table 4. 13** shows the value is still within the confidence level range, allowing 110.18 mm of rainfall per day as the maximum amount to be applied.

4.9.2 Rainfall Intensity using Mononobe Formula

Rain intensity is the amount of rainfall per unit of time, measured in either rain height or rain volume. The length of the rainfall and how often it occurs determine its severity. The rainfall intensity in this design is determined by applying the Mononobe method, as the rainfall data that is provided is daily rainfall data. Before conducting intensity calculations, it is necessary to determine the slope of the dormitory roof and the maximum distance from the rainwater path. In order to simplify calculations, the roof of each dormitory building is divided into multiple segments. **Figure 4. 41** and **Figure 4. 42** is an illustration of the segmentation of roof sections of Abu Bakar and Khonsa dormitory buildings.

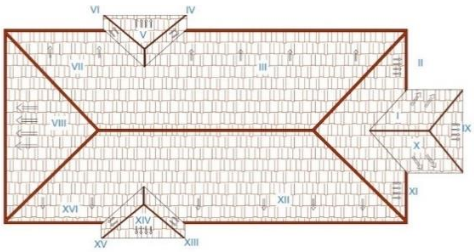


Figure 4. 41 The Segmentation of Roof Section of Abu Bakar Dormitory Building

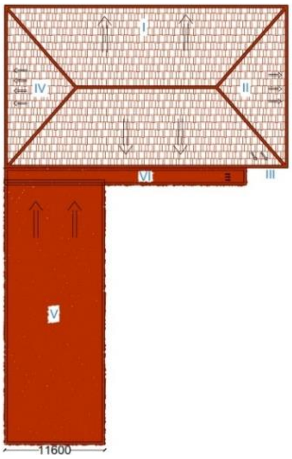


Figure 4. 42 The Segmentation of Roof Section of Khonsa Dormitory Building

The initial stage involves determining the maximum distance from the highest point of the building's roof. Here is an example of the calculation of first segment of the Usman dormitory (Building A)

Lo $= \sqrt{(Height\ of\ the\ roof^2) + (Width\ of\ the\ roof^2)}$

$= \sqrt{(4.27^2) + (7.5^2)}$

= 9.66 m

Next, divide the roof height by the roof width to find the slope. below is an example of the calculation of first segment of the Usman dormitory (Building A)

So $= \frac{Height\ of\ roof}{Width\ of\ roof}$

$= \frac{4.27}{7.5}$

= 0.569

Next, calculate the time of concentration using the Kirpich method

tc $= (\frac{0.87\ x\ Lo^2}{1000\ x\ S})^{0.385}$

$= (\frac{0.87\ x\ 9.66^2}{1000\ x\ 0.569})^{0.385}$

= 0.306 hour

After estimating the time of concentration, you can continue by calculating the rain intensity.

I $= \frac{R_{24}}{24}$ x $(\frac{24}{tc})^{\frac{2}{3}}$

$= \frac{110.18}{24}$ x $(\frac{24}{0.306})^{\frac{2}{3}}$

= 84.1 mm/h

Following a similar way, each segment of the dormitory building is calculated. The results of the rainfall intensity calculation may be seen in the **Table 4. 14** and **Table 4. 15**.

Table 4. 14 Rainfall Intensity Data for each Segment of the Male Dormitory Building

Building	**Segment**	**Lo (m)**	**So**	**tc (hour)**	**Rt(mm)**	**I (mm/hour)**
A	a1	9.66	0.569	0.306	110.18	84.10
	a2	9.66	0.569	0.306	110.18	84.10
B	b1	7.51	0.577	0.253	110.18	95.38
	b2	7.51	0.577	0.253	110.18	95.38
C	c1	2.31	0.577	0.102	110.18	174.66
	c2	3.46	0.274	0.105	110.18	171.76
	c3	8.08	0.577	0.268	110.18	91.81
	c4	3.46	0.577	0.140	110.18	141.84
	c5	3.46	0.274	0.105	110.18	171.76
	c6	3.46	0.577	0.140	110.18	141.84
	c7	8.08	0.577	0.268	110.18	91.81
	c8	3.46	0.274	0.105	110.18	171.76
	c9	2.31	0.516	0.098	110.18	179.73
	c10	2.31	0.577	0.102	110.18	174.66
	c11	3.46	0.274	0.105	110.18	171.76
	c12	8.08	0.674	0.285	110.18	88.25
	c13	3.46	0.577	0.140	110.18	141.84
	c14	3.46	0.516	0.134	110.18	145.96
	c15	3.46	0.577	0.140	110.18	141.84
	c16	8.08	0.674	0.285	110.18	88.25
D	d1	3.18	0.864	0.153	110.18	133.56
	d2	3.18	0.864	0.153	110.18	133.56
	d3	3.18	0.864	0.153	110.18	133.56
	d4	3.18	0.333	0.106	110.18	170.53
	d5	3.18	0.864	0.153	110.18	133.56
	d6	3.18	0.577	0.131	110.18	148.11
	d7	3.18	0.864	0.153	110.18	133.56
	d8	6.60	0.070	0.102	110.18	175.14
E	e1	10.38	0.700	0.350	110.18	76.86
	e2	10.38	0.404	0.284	110.18	88.50
	e3	10.38	0.700	0.350	110.18	76.86
	e4	10.38	0.404	0.284	110.18	88.50
G	g1	8.37	0.577	0.276	110.18	90.17
	g2	8.37	0.577	0.276	110.18	90.17
	g3	8.37	0.577	0.276	110.18	90.17
	g4	8.37	0.577	0.276	110.18	90.17
H	h1	8.08	0.577	0.268	110.18	91.82
	h2	8.08	0.577	0.268	110.18	91.82
I	i1	6.84	0.577	0.236	110.18	100.06
	i2	6.84	0.333	0.191	110.18	115.20
	i3	6.84	0.577	0.236	110.18	100.06
	i4	6.84	0.333	0.191	110.18	115.20

Table 4. 15 Rainfall intensity Data for each Segment of the Female Dormitory Building

Building	Segment	Lo	So	tc	Rt(mm)	I
K	k1	6.2	0.563	0.218	110.18	105.58
	k2	6.2	0.563	0.218	110.18	105.58
L	l1	7.20	0.700	0.264	110.18	92.70
	l2	7.20	4.043	0.519	110.18	59.11
	l3	7.20	0.700	0.264	110.18	92.70
	l4	7.20	0.404	0.214	110.18	106.74
M	m1	5.66	0.594	0.206	110.18	109.46
	m2	5.66	0.594	0.206	110.18	109.46
N	n1	10.06	0.577	0.318	110.18	82.06
	n2	3.58	0.333	0.116	110.18	160.59
	n3	10.06	0.577	0.318	110.18	82.06
	n4	3.58	0.333	0.116	110.18	160.59
	n5	28	0.070	0.310	110.18	83.41
	n6	30	0.070	0.327	110.18	80.51
O	o1	6.58	0.577	0.229	110.18	102.02
	o2	6.58	0.577	0.229	110.18	102.02
	o3	6.35	0.577	0.223	110.18	103.91
	o4	6.35	0.577	0.223	110.18	103.91
	o5	5.20	0.577	0.191	110.18	115.19
	o6	6.35	0.577	0.223	110.18	103.91
P	p1	8.46	0.577	0.278	110.18	89.68
	p2	8.46	0.577	0.278	110.18	89.68
	p3	8.46	0.577	0.278	110.18	89.68
	p4	8.46	0.577	0.278	110.18	89.68
Q	q1	6.1	0.570	0.215	110.18	106.27
	q2	6.1	0.570	0.215	110.18	106.27
R	r1	4.50	0.577	0.171	110.18	123.97
	r2	4.50	0.577	0.171	110.18	123.97
S	r3	4.50	0.577	0.171	110.18	123.97
	r4	4.50	0.577	0.171	110.18	123.97
T	s1	4.5	0.574	0.171	110.18	124.13
	s2	4.5	0.574	0.171	110.18	124.13
V	u1	5.7	0.594	0.206	110.18	109.46
	u2	5.7	0.594	0.206	110.18	109.46

The maximum intensity of rain from each dorm location is utilised to calculate the rainwater harvesting system's component parts. The results of the calculation indicate that the maximum intensity is 179.73 mm/hour in the male area and 160.59 mm/hour in the female area. The rainfall intensity in the male area ranges from 84.1 mm/hour to 179.73 mm/hour. The range for the female student area is between 59.11 mm/hour and 160.59 mm/hour. There is a direct correlation between the length of the water path and the intensity of rain. Specifically, as the length of the water path decreases, the rain intensity increases. The intense rainfall in the male dormitory area can be attributed to the presence of multiple dormitory structures that have little runoff routes. The roof designs of female dorms exhibits less variation. Regarding the size of the roof of buildings, each building in the male area has a similar area, as do all the roof buildings in the female dormitory area.

4.9.3 Dimension of Open Flat Gutters and Rainwater Standpipe

Horizontal open roof gutters are open gutters that surround the roof, which function to accommodate the flow of rainwater from the rain catchment area (building roof). Meanwhile, a standpipe is a closed pipe that channels rainwater from gutters to a reservoir or to the ground.

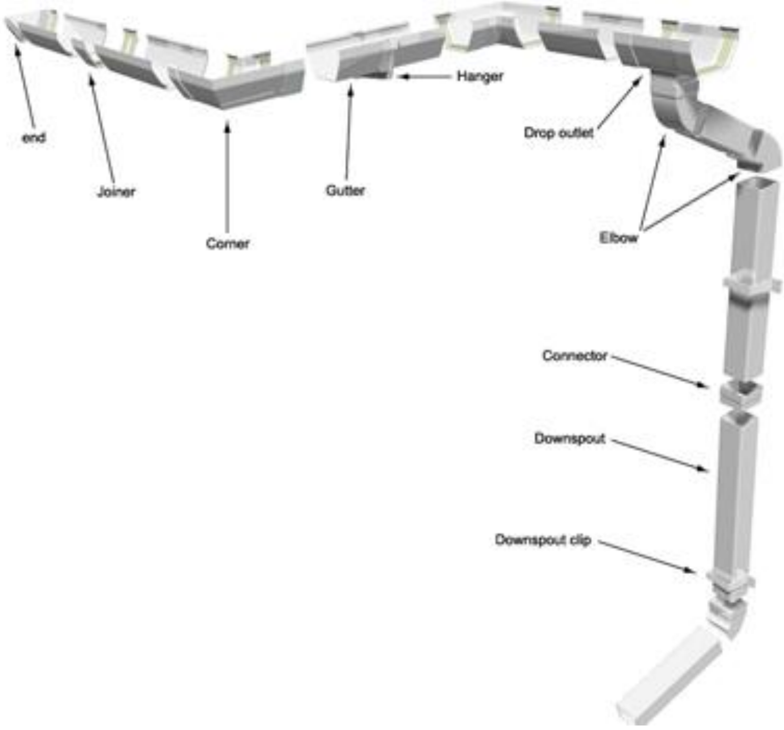


Figure 4. 43 Parts of Open Roof and Standpipes

Figure 4. 43 is shows the segmentation of the open roof gutter and standpipes. The design of gutters and standpipes follows to the guidelines provided in the SNI 03-7065-2005 standard. This reference provides specifications for the appropriate diameters of pipes and gutters based on factors such as roof area, rain intensity, and the slope of the intended gutters.

Table 4. 16 Maximum Permissible Load for Roof Gutters

Pipe Size (mm)	Rainwater Standpipe	Rainwater Drainage Flat Pipe			Open flat roof gutters			
		Slope			Slope			
		1%	2%	4%	1/2%	1%	2%	4%
50	63							
65	120							
80	200	75	105	150	15	20	30	40
100	425	170	245	345	30	45	65	90
125	800	310	435	620	55	80	115	160
150	1290	490	700	990	85	125	175	250
200	2690	1065	1510	2135	180	260	365	520
250		1920	2710	3845	330	470	665	945
300		3090	4365	6185				
350		5525	7800	11055				
Note: This table uses an hourly rainfall of 100 mm. Increased rainfall necessitates changing the area value in the table above by multiplying the result by 10 and dividing the value by								

Pipe Size (mm)	Rainwater Standpipe	Rainwater Drainage Flat Pipe			Open flat roof gutters			
		Slope			Slope			
		1%	2%	4%	1/2%	1%	2%	4%
the additional rainfall measured in millimetres per hour. For rainwater standpipes that are neither cylindrical nor pipe-shaped, any form that the pipe can fit inside the cross-section of is allowed. Roof gutters that don't have a circular form must have the same cross-sectional area.								

(Source: SNI 03-7065-2005)

Table 4.16 uses a maximum rain intensity of 100 mm/hour to calculate pipe size, due to the rainfall intensity exceeding 100 mm/hour, it is necessary to adjust the area value. As per the specifications given in SNI 03-7065-2005, the conversion roof area can be determined by utilizing the following mathematical method.

Convertible roof area $= \frac{\text{Roof area x 10}}{(Rainfall\ intensity - 100)mm/hour}$

Calculation example:
Building A Segment 1
Rainfall intensity : 179.73 mm/hour
Roof area :432 m^2
Converted roof area $= \frac{432 \text{ x } 10}{(310.97-100)mm/hour}$
$= 58.18\ m^2$

The intended slope is set at 1% to determine the diameter of the gutter and standpipe can be seen in the **Table 4. 17** below.

Table 4. 17 Maximum Permissible Load for Roof Gutters

Pipe Size (mm)	Rainwater Standpipe	Rainwater Drainage Flat Pipe			Open flat roof gutters			
		Slope			Slope			
		1%	2%	4%	1/2%	1%	2%	4%
50	63							
65	120							
80	200	75	105	150	15	20	30	40
100	425	170	245	345	30	45	65	90
125	800	310	435	620	55	80	115	160
150	1290	490	700	990	85	125	175	250
200	2690	1065	1510	2135	180	260	365	520
250		1920	2710	3845	330	470	665	945
300		3090	4365	6185				
350		5525	7800	11055				
Note: This table uses an hourly rainfall of 100 mm. Increased rainfall necessitates changing the area value in the table above by multiplying the result by 10 and dividing the value by the additional rainfall measured in millimetres per hour. For rainwater standpipes that are neither cylindrical nor pipe-shaped, any form that the pipe can fit inside the cross-section of is allowed. Roof gutters that don't have a circular form must have the same cross-sectional area.								

Based on the above data, it can be determined that a converted roof area of 54.18 m^2 requires a flat roof gutter with a diameter of 125 mm, and a rainwater standpipe with a diameter of 50 mm. Similarly, the presence of horizontal open gutters and vertical pipes throughout the dormitories yielded the subsequent results that can be seen in **Table 4. 18** and **Table 4. 19** below.

Table 4. 18 The dimensions of the standpipes and flat gutters in every Male Area building

Building	Segment	I (mm/hour)	Roof Area (m^2)	Converted Roof Area (m^2)	Slope	Open Flat Roof Gutters (mm)	Rainwater Standpipe (mm)
A	a1	179.73	432	54.18	0.01	125	50
	a2	179.73					
B	b1	179.73	371	46.55	0.01	125	50
	b2	179.73					
C	c1	179.73	448	56.19	0.01	125	50
	c2	179.73					
	c3	179.73					
	c4	179.73					
	c5	179.73					
	c6	179.73					
	c7	179.73					
	c8	179.73					
	c9	179.73					
	c10	179.73					
	c11	179.73					
	c12	179.73					
	c13	179.73					
	c14	179.73					
	c15	179.73					
	c16	179.73					
D	d1	179.73	170.66	21.40	0.01	100	50
	d2	179.73					
	d3	179.73					
	d4	179.73					
	d5	179.73					
	d6	179.73					
	d7	179.73					
	d8	179.73					
E	e1	179.73	687	86.14	0.01	150	65
	e2	179.73					
	e3	179.73					
	e4	179.73					
G	g1	179.73	655.40	82.20	0.01	150	65
	g2	179.73					
	g3	179.73					
	g4	179.73					
	g5	179.73					
	g6	179.73					
	g7	179.73					
H	h1	179.73	340	42.67	0.01	100	50
	h2	179.73					
I	i1	179.73	300	37.65	0.01	100	50
	i2	179.73					
	i3	179.73					
	i4	179.73					

Table 4. 19 The dimensions of the standpipes and flat gutters in every Female Area building

Building	Segment	I (mm/hour)	Roof Area (m²)	Converted Roof Area (m²)	Slope	Diameter of Open Flat Roof Gutters (mm)	Diameter of Rainwater Standpipe (mm)
K	k1	160.59	279	45.99	0.01	100	50
	k2	160.59					
L	l1	160.59	340	56.08	0.01	125	50
	l2	160.59					
	l3	160.59					
	l4	160.59					
M	m1	160.59	135	22.32	0.01	100	50
	m2	160.59					
N	n1	160.59	766	126.45	0.01	200	65
	n2	160.59					
	n3	160.59					
O	o1	160.59	704	116.22	0.01	150	65
	o2	160.59					
	o3	160.59					
	o4	160.59					
	o5	160.59					
	o6	160.59					
P	p1	160.59	225	37.18	0	100	50
	p2	160.59					
	p3	160.59					
	p4	160.59					
Q	q1	160.59	339	55.98	0.01	125	50
	q2	160.59					
R	r1	160.59	162	26.78	0.01	100	50
	r2	160.59					
S	r3	160.59	162	26.78	0.01	100	50
	r4	160.59					
T	s1	160.59	186	30.64	0.01	100	50
	s2	160.59					
V	u1	160.59	155	25.56	0.01	100	50
	u2	160.59					

4.9.4 Gutter Piping System to the Reservoir

The process of determining the size of a closed flat pipe to reach the reservoir similarly involves following the guidelines outlined in SNI 03-7065-2005 and referring to the same table. In the same way, the diameter of the flat pipe is obtained as **Table 4. 20** and **Table 4. 21** follows

Table 4. 20 Diameter for Flat Pipes for Dormitory Buildings in the Male Section

Building	Segment	I (mm/hour)	Roof Area (m²)	Converted Roof Area (m²)	Slope	Flat Pipe Diameter (mm)
A	a1	179.73	432	54.18	0.01	80
	a2	179.73				
B	b1	179.73	371	46.55	0.01	80
	b2	179.73				
C	c1	179.73	448	56.19	0.01	80
	c2	179.73				
	c3	179.73				

Building	Segment	I (mm/hour)	Roof Area (m²)	Converted Roof Area (m²)	Slope	Flat Pipe Diameter (mm)
	c4	179.73				
	c5	179.73				
	c6	179.73				
	c7	179.73				
	c8	179.73				
	c9	179.73				
	c10	179.73				
	c11	179.73				
	c12	179.73				
	c13	179.73				
	c14	179.73				
	c15	179.73				
	c16	179.73				
D	d1	179.73	170.66	21.40	0.01	80
	d2	179.73				
	d3	179.73				
	d4	179.73				
	d5	179.73				
	d6	179.73				
	d7	179.73				
	d8	179.73				
E	e1	179.73	687	86.14	0.01	100
	e2	179.73				
	e3	179.73				
	e4	179.73				
G	g1	179.73	655.40	82.20	0.01	100
	g2	179.73				
	g3	179.73				
	g4	179.73				
	g5	179.73				
	g6	179.73				
	g7	179.73				
H	h1	179.73	340	42.67	0.01	80
	h2	179.73				
I	i1	179.73	300	37.65	0.01	80
	i2	179.73				
	i3	179.73				
	i4	179.73				

Table 4. 21 Diameter for Flat Pipes for Dormitory Buildings in the Female Section

Building	Segment	I (mm/hour)	Roof Area (m²)	Converted Roof Area (m²)	Slope	Flat Pipe Diameter (mm)
K	k1	160.59	329.35	63.08	0.01	80
	k2	160.59				
L	l1	160.59	390.51	74.80	0.01	80
	l2	160.59				
	l3	160.59				
	l4	160.59				
M	m1	160.59	156.16	29.91	0.01	80
	m2	160.59				
N	n1	160.59	1124.00	215.28	0.01	125
	n2	160.59				
	n3	160.59				

Building	Segment	I (mm/hour)	Roof Area (m^2)	Converted Roof Area (m^2)	Slope	Flat Pipe Diameter (mm)
	n4	160.59				
	n5	160.59				
	n6	160.59				
O	o1	160.59	813.09	155.73	0.01	100
	o2	160.59				
	o3	160.59				
	o4	160.59				
	o5	160.59				
	o6	160.59				
P	p1	160.59	260.13	49.82	0.01	80
	p2	160.59				
	p3	160.59				
	p4	160.59				
Q	q1	160.59	391.67	75.02	0.01	100
	q2	160.59				
R	r1	160.59	187.34	35.88	0.01	80
	r2	160.59				
S	r3	160.59	187.34	35.88	0.01	80
	r4	160.59				
T	s1	160.59	214.36	41.06	0.01	80
	s2	160.59				
V	u1	160.59	178.79	34.24	0.01	80
	u2	160.59				

4.10 Treatment Unit Planning

The objective of the processing unit is to decrease the presence of impurities in rainwater. According to the preceding discussion on the quality of rainwater, it is established that the rainwater collected from the Al Kahfi Islamic Boarding School, specifically at the sampling location for the male dormitory, is of low quality. A simple processing unit was chosen to decrease the levels of excessive *E. Coli* and total coliform, turbidity, color, manganese, chromium, and increase the pH. Here are numerous units that can be utilized for rainwater treatment.

1. Pipe Filter hubcap

   Pipe filter hubcaps serve the purpose of removing large rubbish, such as leaves, twigs, and wood, in order to prevent pipe clogs. **Figure 4. 44** below is the pipe filter hubcap that available at the market.

Figure 4. 44 Pipe Filter hubcap

2. First flush diverter

   First flush diverters are specifically engineered devices that redirect the initial rush of rainwater, which commonly carries various impurities such as trash, leaves, and pollutants. The initial flush diverter unit consists of a vertical pipe that goes to the ground, equipped with a valve at the bottom, and a horizontal pipe that connects to the reservoir.

3. Filter

Before entering the water storage reservoir, a simple filter is designed to process rainwater. Active carbon is the single media filter utilized in the rainwater processing process. Utilizing granular activated carbon has numerous advantages. Activated carbon has the ability to decrease colour levels, raise pH, eliminate manganese by 100%, and reduce total coliform by 86.3% and *E. Coli* by 87.6% (Adewumi et al., 2017). Utilizing activated carbon as a filtering agent can effectively decrease color, total dissolved solids (TDS), and Chromium levels by around 40%, 36%, and 62.5% - 97.83% consequently (Bullo & Bayisa, 2022). FRP tubes are used to store activated carbon filters, as seen in the **Figure 4. 45** below.

Figure 4. 45 Single Media Filter

Planned:

Q Installation = 0.2 L/s = 0.0002 m^3/s

Temperature = 30^0C

μ = 0.000895 kg.m/s

ρ = 995.68 kg/m^3

Number of Tank = 1 unit

Filter Dimension:

Surface Area = π x r x r

= 3.14 x 0.127 x 0.127

= 0.05 m^2

Vf = $\frac{Q}{Af}$

= $\frac{0.0002\ \mathrm{m}^3/\mathrm{s}}{0.05\ \mathrm{m}^2}$

= 0.0039 m/s = 14 m/h (meet the design criteria 5-15 m/h)

Table 4. 22 Specification of Drinking Water Filter

Water Filter	
Maximum Discharge	1000 L/hour
Diameter	10 inches
Type	Backwash automatically
Media Filter	Activated Carbon

Table 4. 22 is shows the specification of filter that suitable with the calculation.

4. Ozonation

The technique of ozonation offers various benefits, specifically its efficiency in eliminating microorganisms as well as synthetic organic and inorganic substances. The process of ozonation has small negative impacts on water. Ozonation produces a substantial impact on the generation of biodegradable molecules that incorporate oxygen atoms in their chemical composition, specifically aldehydes (by-product of ozonation) that are readily biodegradable (Hossen et al., 2023). Although the initial cost of ozonation approach may be higher, it is generally more cost-effective than other process in the long term. Ozonization effectively eliminates heavy metals such as manganese and chromium, with a removal rate of 95.11% and 94.55% respectively (Rekhate & Srivastava, 2021). The removal effectiveness of total coliforms is 99.61% (Fathar et al., 2022). *E. Coli* removal around 78.18% - 100%. Turbidity can be decreased by 86.3% (Wang et al., 2022). The use of ozone can lower colour levels by 14%, and total dissolved solids (TDS) can be lowered by up to 54.4% (Nabavi et al., 2023). **Figure 4. 46** is shows the ozone generator.

Figure 4. 46 Ozonation System

Here is an example of how to calculate the ozone requirements for one of the usman dormitory (A buildings).

<u>Known:</u>

Q : 7200.016L/day
Planned ozone dose : 0.3 mg/L
Contact time : 10 minutes
v assumption : 2 m/s

<u>Calculation:</u>

Requirements of ozone in 1 day = 0.3 mg/L x 7200.016L/day
= 2.16 g/day = 90 mg/h

With the same method the ozone requirements in a day for every building are calculated. The results of calculation can be seen in **Table 4. 23** below.

Table 4. 23 Daily Ozone Gas Requirements

Block	Building	Q (l/s)	Q (L/day)	Ozone Dose (g/day)	Ozone Dose (mg/hr)
Male Area	A	0.08	7200.016	2.16	90
	B	0.09	7920.018	2.38	99
	C	0.10	8400.019	2.52	105
	D	0.06	5280.012	1.58	66
	E	0.19	16560.04	4.97	207
	G	0.13	11040.02	3.31	138
	H	0.11	9840.022	2.95	123
	I	0.09	7920.018	2.38	99
Block	**Building**	**Q (l/s)**	**Q (L/day)**	**Ozone Dose (g/day)**	**Ozone Dose (mg/hr)**
Female Area	K	0.09	7920.018	2.38	99
	L	0.13	10800.02	3.24	135

Block	Building	Q (l/s)	Q (L/day)	Ozone Dose (g/day)	Ozone Dose (mg/hr)
	M	0.03	2880.006	0.86	36
	N	0.24	20400.05	6.12	255
	O	0.22	19200.04	5.76	240
	P	0.06	5280.012	1.58	66
	Q	0.05	4320.01	1.30	54
	R	0.03	2880.006	0.86	36
	S	0.03	2880.006	0.86	36
	T	0.03	2880.006	0.86	36
	V	0.05	4560.01	1.37	57

According to the calculations provided, a market ozone generator with a maximum ozone output of 600 mg/h is utilized.

4.11 Pump Toward Filter

The pump is intended to transport rainwater from the reservoir to the filter unit. The pump utilized is a shallow well pump. The selection of the pump is determined by the maximum daily flow rate and the overall head. Below is an example of how to calculate the total head.

Q Average : 0.2 L/s = 0.0002 m^3/s
v in pump planned : 1 m/s

<u>Calculation:</u>

Area of pipe $= \frac{Q}{v} = \frac{0.0002}{1}$
= 0.002 m

Diameter of pipe $= \sqrt{\frac{A\ pipe\ x\ 4}{3.14}} = \sqrt{\frac{0.002\ x\ 4}{3.14}}$ x 1000
= 16.2 mm

D Pipe Market = 22 mm

v check $= \frac{Q}{A} = \frac{0.0002}{0.25\ x\ 3.14\ x \left(\frac{22}{1000}\right)^2}$
= 0.54 m/s

H static = 2 m
Pipe suction length = 1 m
Pipe discharge length = 1.55 m

Hf Suction $= \frac{Q}{0.2785\ x\ C\ x\ D^{2.63}}$ x L $= \frac{0.0002}{0.2785\ x\ 140\ x\ (\frac{22}{1000})^{2.63}}$ x 1
= 0.0201 m

Hf Discharge $= \frac{Q}{0.2785\ x\ C\ x\ D^{2.63}}$ x L $= \frac{0.002}{0.2785\ x\ 140\ x\ (\frac{60}{1000})^{2.63}}$ x 1.55
= 0.0311 m

Hf Mayor = 0.0201 m + 0.0311 m = 0.051 m

Head velocity $= \frac{v^2}{2\ x\ g} = \frac{0.54^2}{2\ x\ 9.81}$
= 0.015 m

Hf minor turn = n x k x head velocity = 3 x 0.4 x 0.015 m
= 0.0180 m

Hf minor valve = n x k x head velocity = 1 x 0.15 x 0.026
= 0.00225 m

Hf minor = Hf turn + Hf valve + H velocity
= 0.0180 m + 0.00225 m + 0.015 m

	= 0.035 m
H total	= H static + Hf Mayor + Hf Minor
	= 2.086 m
Power Pump	= g x Q x H total x Density = 9.81 x $\frac{7.92}{1000}$ x 2.086 x 999.6
	= 4.2 watt

Table 4. 24 Specification of Pump

Sanyo P-H130B Shallow Well Water Pump (Automatic)	
Maximum Suction Power	9 -3 m
Transmit Power	9 - 17 m
Maximum Capacity	30 L/min
Power	125 Watt

The market pumps that align with the planning calculations mentioned above are pumps that meet the requirements specified in the **Table 4. 24**.

4.12 Secondary Reservoir for Storing Drinking water

This reservoir serves as a temporary storage facility for potable rainwater that has undergone a treatment process. Reservoir calculations rely on the multiplication of demand by service presentation. rainfall is considered an alternate source of water, while groundwater remains the primary supply. Therefore, the utilization of rainfall only accounts for a portion of the overall demand for clean water. The **Table 4. 25** below represents the proportion of rainwater utilization based on the previously calculated savings water .

Table 4. 25 Percentage of Rainwater Usage of each Building

Building	Percentage of Rainwater Usage	Capacity of Ground Reservoir (m^3)
A	87%	6.27
B	68%	5.37
C	77%	6.50
D	47%	2.47
E	60%	9.93
G	61%	6.70
H	45%	4.40
I	44%	3.51
K	51%	4.03
L	46%	4.93
M	68%	1.97
N	54%	11.07
O	53%	10.20
P	62%	3.27
Q	113%	4.90
R	82%	2.37
S	82%	2.37
T	94%	2.70
V	50%	2.27

The following is the calculation example of secondary reservoir

<u>Known:</u>

Building : A (Usman Dormitory)
Water Demand : 7.2 m^3/day
Service Percentage : 87%

Calculation:

Reservoir capacity = 7.2 x 87%

= 6.27 m^3/day = 6270 L/day

Since the reservoir capacity use daily unit of the volume, therefore the reservoir is designed to have a capacity of 6,270 L. With the same method the capacity of the secondary reservoir is calculated. **Table 4. 26** are the calculation result of secondary reservoir capacity.

Table 4. 26 Capacity of Secondary Reservoir

Building	Percentage of Rainwater Usage	Capacity of Reservoir (m^3)
A	87%	6.27
B	68%	5.37
C	77%	6.50
D	47%	2.47
E	60%	9.93
G	61%	6.70
H	45%	4.40
I	44%	3.51
K	51%	4.03
L	46%	4.93
M	68%	1.97
N	54%	11.07
O	53%	10.2
P	62%	3.27
Q	113%	4.90
R	82%	2.37
S	82%	2.37
T	94%	2.70
V	50%	2.27

The secondary reservoir will use a ground reservoir where the details of the work will be explained in the next sub-chapter.

4.13 Distribution Pump

A distribution pump is a device used to transport ready-to-drink water from a secondary reservoir to a tap. The pump utilized is a submersible pump designed expressly for the purpose of pumping clean water. Below is an illustration of the calculations involved in establishing pump specifications.

Building : A (Usman Dormitory)

Q Average : 0.07 L/s = 0.00007 m^3/s

v in pump planned : 1 m/s

Calculation:

Area of pipe $= \frac{Q}{v} = \frac{0.0002}{1}$

= 0.00007 m

Diameter of pipe $= \sqrt{\frac{A\ pipe\ x\ 4}{3.14}} = \sqrt{\frac{0.00007\ x\ 4}{3.14}}$ x 1000

= 9.6 mm

D Pipe Market = 22 mm

v check $= \frac{Q}{A} = \frac{0.00007}{0.25\ x\ 3.14\ x\ \left(\frac{22}{1000}\right)^2}$

= 0.19 m/s

H static = 3.5 m

Pipe suction length = 2.5 m

Pipe discharge length = 1.5 m

Hf Suction $= \frac{Q}{0.2785\ x\ C\ x\ D^{2.63}}$ x L = $\frac{0.00007}{0.2785\ x\ 140\ x\ (\frac{22}{1000})^{2.63}}$ x 2.5

= 0.0073 m

Hf Discharge $= \frac{Q}{0.2785\ x\ C\ x\ D^{2.63}}$ x L = $\frac{0.00007}{0.2785\ x\ 140\ x\ (\frac{22}{1000})^{2.63}}$ x 1.5

= 0.0044 m

Hf Mayor = 0.0073 m + 0.0044 m = 0.012 m

Head velocity $= \frac{v^2}{2\ x\ g} = \frac{0.19^2}{2\ x\ 9.81}$

= 0.002 m

Hf minor turn = n x k x head velocity = 3 x 0.4 x 0.002 m

= 0.0022 m

Hf minor valve = n x k x head velocity = 1 x 0.15 x 0.002

= 0.00028 m

Hf minor = Hf turn + Hf valve + H velocity

= 0.0022 m + 0.00028 m + 0.002 m

= 0.004 m

H total = H static + Hf Mayor + Hf Minor

= 3.516 m

Power Pump = g x Q x H total x Density = 9.81 x $\frac{7.92}{1000}$ x 3.156 x 999.6

= 2.49 watt

With the same method the total head of pump is calculated. **Table 4. 27** shows the calculation result of total head of pump for each ground reservoir.

Table 4. 27 Total Head Calculation Result

Q (m3/day)	A Pipe (m)	D Pipe (mm)	Market Pipe (mm)	V Check (m/s)	H Static (m)	Hf Mayor (m)	Head Velocity (m)	Hf Minor (m)	H total (m)	Power Pump (Watt)
6.27	0.00007	9.6	22	0.19	3.50	0.012	0.002	0.004	3.516	2.49
5.37	0.00006	8.9	22	0.16	3.50	0.009	0.001	0.004	3.512	2.13
6.50	0.00008	9.8	22	0.20	3.50	0.012	0.002	0.005	3.518	2.58
2.47	0.00003	6.0	22	0.08	3.50	0.002	0.000	0.001	3.503	0.98
9.93	0.00011	12.1	22	0.30	3.50	0.027	0.005	0.013	3.540	3.98
6.70	0.00008	9.9	22	0.20	3.50	0.013	0.002	0.006	3.519	2.67
4.40	0.00005	8.1	22	0.13	3.50	0.006	0.001	0.003	3.509	1.74
3.51	0.00004	7.2	22	0.11	3.50	0.004	0.001	0.002	3.506	1.39

Q (m3/day)	A Pipe (m)	D Pipe (mm)	Market Pipe (mm)	V Check (m/s)	H Static (m)	Hf Mayor (m)	Head Velocity (m)	Hf Minor (m)	H total (m)	Power Pump (Watt)
4.03	0.00005	7.7	22	0.12	3.50	0.005	0.001	0.002	3.507	1.60
4.93	0.00006	8.5	22	0.15	3.50	0.007	0.001	0.003	3.511	1.96
1.97	0.00002	5.4	22	0.06	3.50	0.001	0.000	0.001	3.502	0.78
11.07	0.00013	12.8	22	0.34	3.50	0.033	0.006	0.016	3.549	4.44
10.20	0.00012	12.3	22	0.31	3.50	0.029	0.005	0.014	3.542	4.08
3.27	0.00004	6.9	22	0.10	3.50	0.003	0.001	0.001	3.505	1.29
4.90	0.00006	8.5	22	0.15	3.50	0.007	0.001	0.003	3.511	1.94
2.37	0.00003	5.9	22	0.07	3.50	0.002	0.000	0.001	3.503	0.94
2.37	0.00003	5.9	22	0.07	3.50	0.002	0.000	0.001	3.503	0.94
2.70	0.00003	6.3	22	0.08	3.50	0.002	0.000	0.001	3.503	1.07
2.27	0.00003	5.8	22	0.07	3.50	0.002	0.000	0.001	3.502	0.90

Table 4. 28 Specification of Submersible Pump

Shimizu Submersible Pump SPN-250 BIT	
Output	250 W
Maximum Head	13 m
Input	0.44 kW
Maximum Capacity	130 L/min

Based on the previously mentioned computational findings, a specific kind of pump is chosen with the specification written in the **Table 4. 28**.

4.14 Estimation of Removal Efficiency

The number of pollutants that can be eliminated after undergoing treatment is estimated by means of pollutant removal estimations. Several journals provide removal efficiency, estimated calculation of the number of contaminants removed following filtering and ozonation processing are provided in the **Table 4. 29** until **Table 4. 32**.

Table 4. 29 The Quality of Treated Rainwater at Sampling Point 1

Parameter	Quality Standard	Filter		Ozonation		Description
		% R	Effluent	% R	Effluent	
E. Coli	0 CFU/100 ml	-	79.000	100%[10]	0	Complied
Total Coliform	0 CFU/100 ml	51.4%[1]	50.544	99.61%[9]	0	Complied
Temperature	Air Temperature ±3 ^{0}C	-	25,6	-	25,6	Complied
TDS	<300 mg/L	50%[2]	8.25	5%[11]	7.84	Complied
Turbidity	<3	80%[3]	0.110	18.12%[12]	0.090	Complied
Colour	10 NTU	58.4%[4]	0.188	60%[5]	0.08	Complied
pH	6.5 – 8.5	18.7%[6]	6.8	-	6.8	Complied
Nitrite	3 mg/L	-	0.058	-	0.058	Complied
Chromium	0.01 mg/L	62.5%[7]	0.008	-	0	Complied

Iron	0.2 mg/L	-	0.030	-	0.030	Complied
Manganese	0.1 mg/L	99.39%[8]	0	98%[13]	0	Complied
Lead	0.01 mg/L	-	<0.01	-	<0.01	Complied
Fluoride	1.5 mg/L	-	0.25	-	0.25	Complied
Aluminium	0.2 mg/L	-	0.065	-	0.065	Complied

Table 4. 30 The Quality of Treated Rainwater at Sampling Point 3

Parameter	Quality Standard	Single Media Filter		Ozonation		Description
		% R	Effluent	% R	Effluent	
E. Coli	0 CFU/100 ml	-	5	100%[10]	0	Complied
Total Coliform	0 CFU/100 ml	51.4%[1]	9.234	99.61%[9]	0	Complied
Temperature	Air Temperature ±3 ^{0}C	-	25,2	-	25,2	Complied
TDS	<300 mg/L	50%[2]	22.000	5%[11]	20.90	Complied
Turbidity	<3	80%[3]	0.648	18.12%[12]	0.531	Complied
Colour	10 NTU	58.4%[4]	34.528	60%[5]	9.88	Complied
pH	6.5 – 8.5	18.7%[6]	7.48	-	7.48	Complied
Nitrite	3 mg/L	-	0,0145	-	0,0145	Complied
Chromium	0.01 mg/L	62.5%[7]	0.019	-	0	Complied
Iron	0.2 mg/L	-	0.065	-	0.030	Complied
Manganese	0.1 mg/L	99.39%[8]	0.002	98%[13]	0	Complied
Lead	0.01 mg/L	-	0.01	-	0.01	Complied
Fluoride	1.5 mg/L	-	0.07	-	0.07	Complied
Aluminium	0.2 mg/L	-	0.05	-	0.05	Complied

Table 4. 31 The Quality of Treated Rainwater at Sampling Point 4

Parameter	Quality Standard	Single Media Filter		Ozonation		Description
		% R	Effluent	% R	Effluent	
E. Coli	0 CFU/100 ml	-	5.00	100%[10]	0	Complied
Total Coliform	0 CFU/100 ml	51.4%[1]	11.664	99.61%[9]	0	Complied
Temperature	Air Temperature ±3 ^{0}C	-	26.15	-	26.150	Complied
TDS	<300 mg/L	50%[2]	13.50	5%[11]	12.83	Complied
Turbidity	<3	80%[3]	0.4	18.12%[12]	0.328	Complied
Colour	10 NTU	58.4%[4]	0.15	60%[5]	0.06	Complied
pH	6.5 – 8.5	18.7%[6]	8.5	-	8.50	Complied
Nitrite	3 mg/L	-	0.07	-	0.07	Complied
Chromium	0.01 mg/L	62.5%[7]	0.004	-	0	Complied
Iron	0.2 mg/L	-	0.020	-	0.03	Complied
Manganese	0.1 mg/L	99.39%[8]	0	98%[13]	0	Complied
Lead	0.01 mg/L	-	0.01	-	0.01	Complied
Fluoride	1.5 mg/L	-	0.06	-	0.06	Complied
Aluminium	0.2 mg/L	-	0.06	-	0.06	Complied

Table 4. 32 The Quality of Treated Rainwater at Sampling Point 5

Parameter	Quality Standard	Single Media Filter		Ozonation		Description
		% R	Effluent	% R	Effluent	

E. Coli	0 CFU/100 ml	-	8.00	100%[10]	0	Complied
Total Coliform	0 CFU/100 ml	51.4%[1]	18.95	99.61%[9]	0	Complied
Temperature	Air Temperature $\pm 3\ ^{0}C$	-	25,75	-	25,75	Complied
TDS	<300 mg/L	50%[2]	8.50	5%[11]	8.08	Complied
Turbidity	<3	80%[3]	0.23	18.12%[12]	0.186	Complied
Colour	10 NTU	58.4%[4]	0.56	60%[5]	0.22	Complied
pH	6.5 – 8.5	18.7%[6]	8.5	-	8.50	Complied
Nitrite	3 mg/L	-	0.03	-	0.03	Complied
Chromium	0.01 mg/L	62.5%[7]	0	-	0	Complied
Iron (Fe)	0.2 mg/L	-	0.06	-	0.03	Complied
Manganese (Mn)	0.1 mg/L	99.39%[8]	0.00	98%[13]	0	Complied
Lead (Pb)	0.01 mg/L	-	0.01	-	0.01	Complied
Fluoride (F)	1.5 mg/L	-	0.16	-	0.16	Complied
Aluminium (Al)	0.2 mg/L	-	0.07	-	0.07	Complied

(Source: [1](Bayable et al., 2020); [2](Erabee & Ethaib, 2018); [3](Hatt et al., 2013); [4](Mohammed et al., 2013); [5](Dąbrowska, 2021); [6](Ariyani et al., 2020); [7](Bullo & Bayisa, 2022); [8](Ismail et al., 2017); [9](Fathar et al., 2022); [10](bhakti, 2012); [11](Dianawati et al., 2018); [12](Jamalinezhad et al., 2021); [13](Tewalt et al., 2005))

A final effluent with a value that satisfies quality standards for all parameters is obtained based on the removal efficiency calculation.

4.15 Rainwater Harvesting Scheme

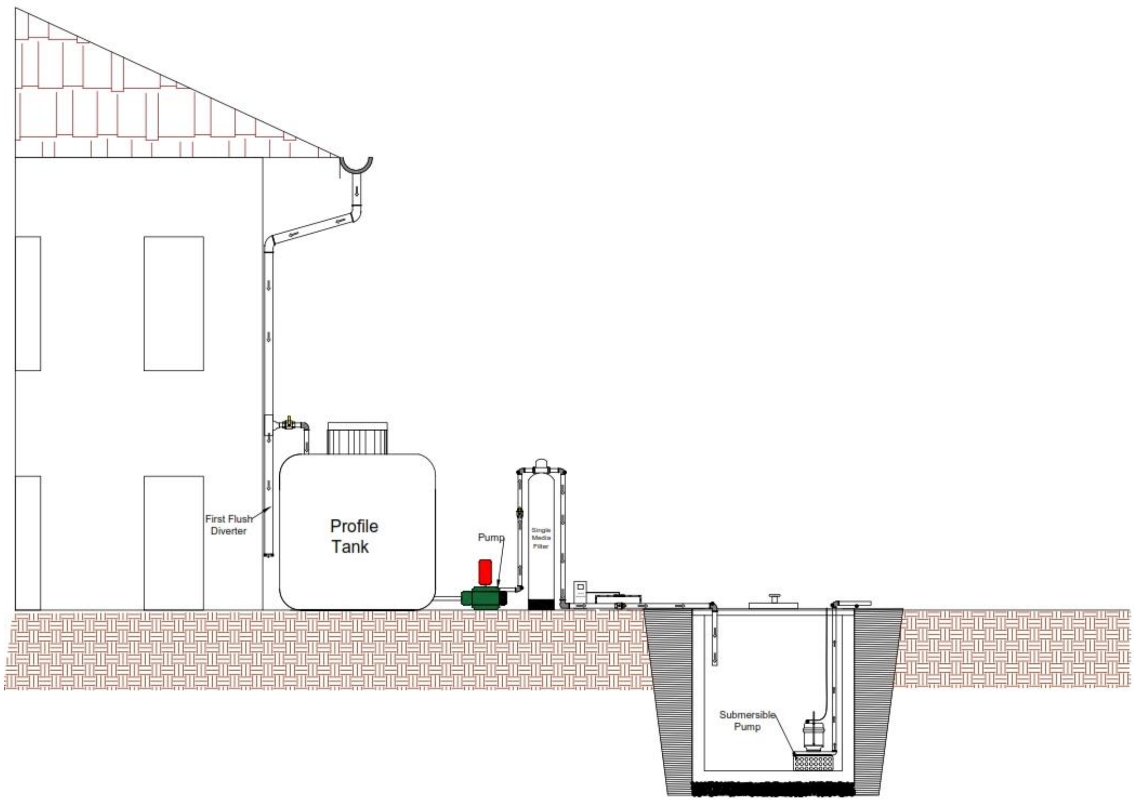


Figure 4. 47 Rainwater Harvesting Scheme

1. The rainwater harvesting scheme starts with the rainfall that falls on the rooftop of the building, then channelling into the gutter attached to the edge of the roof.
2. Water flowing and enters the standpipe.
3. During the initial ten minutes, water is purposely discharged from the first flush diverter to prevent the entry of water contaminated with contaminants from the roof and gutters into the filter
4. After a duration of ten minutes, as water enters the diverter chamber, the ball will rise to block the entry to the diverter.
5. Subsequently, the water will be directed into the profile tank.
6. Once starting the pump, the water stored in the profile tank will be drawn into the filter inlet.
7. The purified water will exit from the filter and be directed to the tapping pipe for ozone injection
8. Ozone-treated water will be stored temporary in the ground reservoir

To obtain a more clear and precise visual representation, please refer to the appendix

Every building has a rainwater harvesting system installed so that the cleaned water flows straight into the existing pipes. The water will then be connected to a piping system that supplies each dorm's drinking water taps. The drinking water taps in the dorms are seen in the **Figure 4. 48** below.

Figure 4. 48 Drinking Water Tap

4.16 Calculation of BOQ and Cost Budget Plan

4.13.1 Bill of quantity (BOQ)

Bill of quantity (BOQ) is a breakdown of the amount of equipment and work required when construction. The total number of volume component demands will then be applied in the calculation of the planned cost (RAB). The BOQ calculation is divided down into two sections: demands for gutters pipes system including accessories for gutters and pipes, ground reservoir work, which includes excavating soil, calculating the amount of sand fill, concrete, wall formwork, cover plates, and ceramic tiles.

1. **Bill of Quantity of Pipe and Gutter System**

Every structure has its own set of standards for pipes and gutters. **Table 4. 33** and **Table 4. 34** are the gutter, pipe, and accessories require that were determined.

Table 4. 33 BOQ Gutter and Piping Systems

No	Material	Building	Demand (m)	Market Size (m)	Total (Pcs)
1	Water gutter (semi-circular PVC pipe 6 inches diameter)	A	57.6	4	15
		B	55.4	4	14
		C	98	4	25
		D	42	4	11
		E	114.8	4	29
		G	125.1	4	32
		H	59.8	4	15
		I	76.0	4	19
		K	51.6	4	13
		L	79.2	4	20
		M	27.6	4	7
		O	121.4	4	31
		P	51.2	4	13
		Q	64	4	16
		R	41.6	4	11
		S	41.6	4	11
		T	47.6	4	12
		V	31.6	4	8
		Total	1186		302
4	Water gutter (semi-circular PVC pipe 8 inches diameter)	N	55.6	4	14
		Total	55.6		14
5	Standpipe (PVC pipe 50 mm diameter)	A	7.50	4	2
		B	8.30	4	2
		C	10.00	4	3
		D	9.50	4	3
		H	7.60	4	3
		I	11.00	4	2
		K	11.00	4	3
		L	12.00	4	3
		M	9.00	4	3
		P	8.40	4	3
		Q	8.40	4	3
		R	10.60	4	3
		S	10.60	4	3
		T	8.30	4	3
		V	9.00	4	3
		Total	141.20		42
6	Standpipe (PVC pipe 65 mm diameter)	E	11.00	4	3
		G	10.30	4	3
		O	10.00	4	3
		N	10.00	4	3
		Total	41.30		12
7	Flat pipe (PVC pipe 80 mm diameter)	A	22	4	6
		B	20.4	4	6
		C	20	4	5
		D	11.7	4	3
		H	18.2	4	5
		I	6.2	4	2
		K	16.8	4	5
		L	6	4	2
		M	15.8	4	4

No	Material	Building	Demand (m)	Market Size (m)	Total (Pcs)
		P	24.1	4	7
		R	13.8	4	4
		S	13.8	4	4
		T	13.8	4	4
		V	15.8	4	4
		Total	218.4		61
8	Flat pipe (PVC pipe 125 mm diameter)	N	6	4	2
		Total	6		2
9	Flat pipe (PVC pipe 100 mm diameter)	E	6.2	4	2
		G	20.4	4	6
		O	27.4	4	7
		Q	16.6	4	5
		Total	70.6		20

Table 4. 34 Requirements for Gutter and Pipe Accessories Rainwater Harvesting System

No	Material	Building	Demand (Pcs)	No	Material	Building	Demand (Pcs)
1	Gutter joint (6 inches)	A	16	**14**	Pipe Clamps (50 mm)	A	15
		B	15			B	17
		C	26			C	20
		D	16			D	19
		E	30			H	15
		G	33			I	22
		H	16			K	22
		I	20			L	24
		K	14			M	18
		L	21			P	17
		M	8			Q	17
		O	32			R	22
		P	14			S	22
		Q	17			T	17
		R	12			V	18
		S	12			Total	285
		T	13	**15**	Reducer (3" x 2")	A	1
		V	9			B	1
		Total	324			C	1
2	Gutter joint (8 inches)	N	15			D	1
		Total	15			E	1
3	Gutter bracket (6 inches)	A	72			G	1
		B	69			H	1
		C	123			I	1
		D	53			M	1
		E	144			P	1
		G	156			R	1
		H	75			S	1
		I	95			T	1
		K	65			V	1
		L	99			Total	14
		M	35	**16**	Gutter outlet (6 inches)	A	1
		O	152			B	1
		P	64			C	1
		Q	80			D	1
		R	52			E	1
		S	52			G	1
		T	60			H	1
		V	40			I	1

No	Material	Building	Demand (Pcs)	No	Material	Building	Demand (Pcs)
		Total	1483			K	1
4	Gutter bracket (8 inches)	N	70			L	1
		Total	70			M	1
5	Pipe filter hub (50 mm)	A	1			O	1
		B	1			P	1
		C	1			Q	1
		D	1			R	1
		H	1			S	1
		I	1			T	1
		K	1			V	1
		L	1			Total	18
		M	1	**17**	Elbows AW 45° 2 inches	A	6
		P	1			B	6
		Q	1			C	6
		R	1			D	6
		S	1			H	6
		T	1			I	6
		V	1			K	6
		Total	15			L	6
6	Pipe filter hub (65 mm)	E	1			M	6
		G	1			P	6
		O	1			Q	6
		N	1			R	6
		Total	4			S	6
7	Ball valve (2 inches)	A	3			T	6
		B	3			V	6
		C	3			Total	84
		D	3	**18**	Elbows AW 45° 3 inches	E	6
		H	3			G	6
		I	3			O	6
		K	3			N	6
		L	3			Total	24
		M	3	**19**	Reducer knee (2" x 4")	K	2
		P	3			L	2
		Q	3			M	2
		R	3			N	2
		S	3			O	2
		T	3			P	2
		V	3			Q	2
		Total	45			R	2
8	Ball valve (3 inches)	E	3			S	2
		G	3			T	2
		O	3			V	2
		N	3			Total	22
		Total	12	**20**	Tee pipe	A	3
9	Faucet socket (1/2 x 2")	A	2			B	3
		B	2			C	3
		C	2			D	3
		D	2			E	3
		E	2			G	3
		G	2			H	3
		H	2			I	3
		I	2			K	3
		K	2			L	3
		L	2			M	3
		M	2			N	3

No	Material	Building	Demand (Pcs)	No	Material	Building	Demand (Pcs)
		N	2			O	3
		O	2			P	3
		P	2			Q	3
		Q	2			R	3
		R	2			S	3
		S	2			T	3
		T	2			V	3
		V	2			Total	57
		Total	38	**21**	Venturi Pipe	A	1
10	Gutter stop end (6 inches)	A	2			B	1
		B	2			C	1
		C	2			D	1
		D	2			E	1
		E	2			G	1
		G	2			H	1
		H	2			I	1
		I	2			K	1
		K	2			L	1
		L	2			M	1
		M	2			N	1
		O	2			O	1
		P	2			P	1
		Q	2			Q	1
		R	2			R	1
		S	2			S	1
		T	2			T	1
		V	2			V	1
		Total	36			Total	19
11	Gutter stop end (8 inches)	N	2	**22**	Gutter Angle (6 inches)	C	16
		Total	2			D	5
12	Pipe Clamps (65 mm)	E	22			E	4
		G	21			G	3
		O	20			I	4
		N	20			L	4
		Total	83			Total	36
12	Gutter outlet (8 inches)	N	1	**23**	Gutter Angle (8 inches)	N	1
		Total	1			O	6
						Total	7

2. Soil Excavation

Soil excavation is carried out with a trapezoidal side view. **Figure 4. 1** is an illustration of soil excavations.

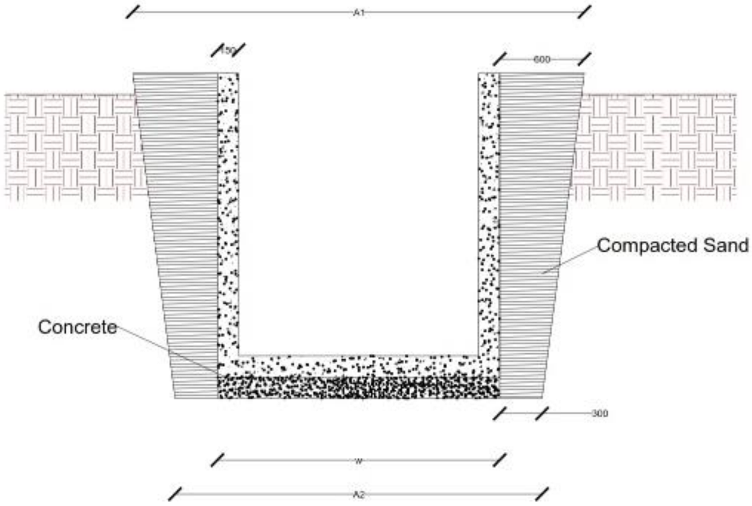


Figure 4. 49 Typical Excavation Size

Because the excavation is trapezoidal in shape, the excavation volume can be calculated using the following equation.

Excavation volume : $\frac{1}{2}$ x (A1 +A2) x y x L

Where:

y : Depth of construction + thick sand (15 cm)

L : Length of construction

Here is an example of how to calculate the excavation volume for ground reservoir of dormitory building A.

<u>Known:</u>

Reservoir depth : 2 m

Reservoir length : 4 m

Reservoir width : 1 m

<u>Calculation:</u>

Excavation volume = $\frac{1}{2}$ x (A1 +A2) x y x L

= $\frac{1}{2}$ x (2.5 m + 1.9 m) x 2.3 m x 4

= 20.24 m^3

Using the same way, the volume of excavation for every building are calculated. **Table 4. 35** are the results of the calculations.

Table 4. 35 Volume of Excavation of Ground Reservoir for each Building

Block	Building	Volume of Reservoir (m^3/day)	Depth (m)	Area (m^2)	Dimensions		Excavation Volume (m^3)
					Length (m)	Width (m)	
Male Area	A	6.27	2	4.0	4	1	20.24
	B	5.37	2	3.0	3	1	15.18
	C	6.50	2	4.0	4	1	20.24
	D	2.47	2	2.0	2	1	10.12
	E	9.93	2	5.0	2	2	17.67
	G	6.70	2	4.0	4	1	20.24
	H	4.40	2	3.0	3	1	15.18
	I	3.51	2	2.0	2	1	10.12

Block	Building	Volume of Reservoir (m^3/day)	Depth (m)	Area (m^2)	Dimensions		Excavation Volume (m^3)
					Length (m)	Width (m)	
Female Area	K	4.03	2	3.0	2	1	10.12
	L	4.93	2	3.0	3	1	15.18
	M	1.97	2	1.0	1	1	5.06
	N	11.07	2	6.0	6	1	30.36
	O	10.20	2	6.0	6	1	30.36
	P	3.27	2	2.0	2	1	10.12
	Q	4.90	2	3.0	3	1	15.18
	R	2.37	2	2.0	2	1	10.12
	S	2.37	2	2.0	2	1	10.12
	T	2.70	2	2.0	2	1	10.12
	V	2.27	2	2.0	2	1	10.12

3. Volume of Sand Backfill

The volume of a sand filling can be determined by multiplying the area of the base with the height of the sand filling. Here is an example of the calculations for constructing reservoir A.

Volume of sand filling = Area of reservoir x depth of backfill
= 4 m x 1 m x 0.15 m
= 0.60 m^3

Using the same way, the volume of sand backfill for every building are calculated. **Table 4. 36** are the results of the calculations.

Table 4. 36 Volume of Sand Backfill of Ground Reservoir for each Building

Block	Building	Volume of Reservoir (m^3/day)	Depth (m)	Area (m^2)	Dimensions		Volume of Sand Fill (m^3)
					Length (m)	Width (m)	
Male Area	A	6.27	2	4	4	1	0.60
	B	5.37	2	3	3	1	0.45
	C	6.50	2	4	4	1	0.60
	D	2.47	2	2	2	1	0.30
	E	9.93	2	5	2	2	0.75
	G	6.70	2	4	4	1	0.60
	H	4.40	2	3	3	1	0.45
	I	3.51	2	2	2	1	0.30
Female Area	K	4.03	2	3	2	1	0.45
	L	4.93	2	3	3	1	0.45
	M	1.97	2	1	1	1	0.15
	N	11.07	2	6	6	1	0.90
	O	10.20	2	6	6	1	0.90
	P	3.27	2	2	2	1	0.30
	Q	4.90	2	3	3	1	0.45
	R	2.37	2	2	2	1	0.30

Block	Building	Volume of Reservoir (m^3/day)	Depth (m)	Area (m^2)	Dimensions		Volume of Sand Fill (m^3)
					Length (m)	Width (m)	
	S	2.37	2	2	2	1	0.30
	T	2.70	2	2	2	1	0.30
	V	2.27	2	2	2	1	0.30

4. Volume of Concrete K225

Below is an illustration of calculations for the construction of ground water storage facility for building A.

Volume of concrete = Vol. of tank with the wall – vol. of effective tank
= (0.15 x 1 x 0.15) x (2+0.15) x 4) – (1 x 4 x 2)
= 3.18 m^3

Using the same way, the volume of concrete for every building are calculated. **Table 4. 37** are the results of the calculations.

Table 4. 37 Volume of Concrete of Ground Reservoir for each Building

Block	Building	Volume of Reservoir (m^3/day)	Depth (m)	Area (m^2)	Dimensions		Volume of Concrete (m^3)
					Length (m)	Width (m)	
Male Area	A	6.27	2	4.0	4	1	3.18
	B	5.37	2	3.0	3	1	2.39
	C	6.50	2	4.0	4	1	3.18
	D	2.47	2	2.0	2	1	1.59
	E	9.93	2	5.0	2	2	2.19
	G	6.70	2	4.0	4	1	3.18
	H	4.40	2	3.0	3	1	2.39
	I	3.51	2	2.0	2	1	1.59
Female Area	K	4.03	2	3.0	2	1	1.59
	L	4.93	2	3.0	3	1	2.39
	M	1.97	2	1.0	1	1	0.79
	N	11.07	2	6.0	6	1	4.77
	O	10.20	2	6.0	6	1	4.77
	P	3.27	2	2.0	2	1	1.59
	Q	4.90	2	3.0	3	1	2.39
	R	2.37	2	2.0	2	1	1.59
	S	2.37	2	2.0	2	1	1.59
	T	2.70	2	2.0	2	1	1.59
	V	2.27	2	2.0	2	1	1.59

5. Wall Formwork

The formwork for the water tank is the same as the surface area of the tank walls. Below is an example of the calculations for constructing building A.

Wall formwork = tank wall area
= (2 x 1 x 2) + (2 x 4 x 2)

= 20 m²

Using the same way, the volume of wall formwork for every building are calculated. **Error! Reference source not found.** are the results of the calculations

Table 4. 38 Wall Formwork Requirements of Ground Reservoir for each Building

Block	Building	Volume of Reservoir (m^3/day)	Depth (m)	Area (m^2)	Dimensions		Wall Formwork (m^2)
					Length (m)	Width (m)	
Male Area	A	6.27	2	4.0	4	1	20
	B	5.37	2	3.0	3	1	16
	C	6.50	2	4.0	4	1	20
	D	2.47	2	2.0	2	1	12
	E	9.93	2	5.0	2	2	17.89
	G	6.70	2	4.0	4	1	20
	H	4.40	2	3.0	3	1	16
	I	3.51	2	2.0	2	1	12
Female Area	K	4.03	2	3.0	2	1	12
	L	4.93	2	3.0	3	1	16
	M	1.97	2	1.0	1	1	8
	N	11.07	2	6.0	6	1	28
	O	10.20	2	6.0	6	1	28
	P	3.27	2	2.0	2	1	12
	Q	4.90	2	3.0	3	1	16
	R	2.37	2	2.0	2	1	12
	S	2.37	2	2.0	2	1	12
	T	2.70	2	2.0	2	1	12
	V	2.27	2	2.0	2	1	12

6. Cover Plate

The size of the tank cover plate is determined by considering the volume of the manhole cover, which measures 0.6 m x 0.6 m and is used for cleaning purposes. Below is an example of the calculations for constructing building A.

Vol. of cover plate = Vol. full cover – vol. manhole cover

= ((0.15+1+0.15) x (0.15+4+0.15) x 0.15) - (0.6x0.6x0.15)

= 0.78 m³

Using the same way, the volume of cover plate for every building are calculated. **Table 4. 39** are the results of the calculations

Table 4. 39 Volume of Plate Cover of Ground Reservoir for each Building

Block	Building	Volume of Reservoir (m^3/day)	Depth (m)	Area (m^3)	Dimensions		Cover Plate (m^3)
					Length (m)	Width (m)	
Male Area	A	6.27	2	4.0	4	1	0.78
	B	5.37	2	3.0	3	1	0.59
	C	6.50	2	4.0	4	1	0.78

Block	Building	Volume of Reservoir (m³/day)	Depth (m)	Area (m³)	Dimensions		Cover Plate (m³)
					Length (m)	Width (m)	
	D	2.47	2	2.0	2	1	0.39
	E	9.93	2	5.0	2	2	0.91
	G	6.70	2	4.0	4	1	0.78
	H	4.40	2	3.0	3	1	0.59
	I	3.51	2	2.0	2	1	0.39
Female Area	K	4.03	2	3.0	2	1	0.39
	L	4.93	2	3.0	3	1	0.59
	M	1.97	2	1.0	1	1	0.20
	N	11.07	2	6.0	6	1	1.17
	O	10.20	2	6.0	6	1	1.17
	P	3.27	2	2.0	2	1	0.39
	Q	4.90	2	3.0	3	1	0.59
	R	2.37	2	2.0	2	1	0.39
	S	2.37	2	2.0	2	1	0.39
	T	2.70	2	2.0	2	1	0.39
	V	2.27	2	2.0	2	1	0.39

7. Ceramic Tiles 30 x 30

The example of calculating the area for the installation of ceramic tiles can be seen as **Table 4. 40** follows.

Total Area = area of tank wall + area of floor tank
= ((2 x 1) x 2) + ((2 x 4) x 2) + (4 x 1)
= 24 m²

Table 4. 40 Installation of Ceramic Tiles Requirements

Block	Building	Volume of Reservoir (m³/day)	Depth (m)	Area (m²)	Dimensions		Ceramic Tiles 30x 30 (m²)
					Length (m)	Width (m)	
Male Area	A	6.27	2	4.0	4	1	24.00
	B	5.37	2	3.0	3	1	19.00
	C	6.50	2	4.0	4	1	24.00
	D	2.47	2	2.0	2	1	14.00
	E	9.93	2	5.0	2	2	22.89
	G	6.70	2	4.0	4	1	24.00
	H	4.40	2	3.0	3	1	19.00
	I	3.51	2	2.0	2	1	14.00
Female Area	K	4.03	2	3.0	2	1	14.00
	L	4.93	2	3.0	3	1	19.00
	M	1.97	2	1.0	1	1	9.00
	N	11.07	2	6.0	6	1	34.00
	O	10.20	2	6.0	6	1	34.00
	P	3.27	2	2.0	2	1	14.00

Block	Building	Volume of Reservoir (m³/day)	Depth (m)	Area (m²)	Dimensions		Ceramic Tiles 30x 30 (m²)
					Length (m)	Width (m)	
	Q	4.90	2	3.0	3	1	19.00
	R	2.37	2	2.0	2	1	14.00
	S	2.37	2	2.0	2	1	14.00
	T	2.70	2	2.0	2	1	14.00
	V	2.27	2	2.0	2	1	14.00

4.13.2 Cost Budget Plan (RAB)

The cost budget plan shows the total expenses that are necessary for the construction of a project. The budget plan calculation relies on the 2023 Bogor City HSPK and HSPK Bogor City 2022 due to the unavailability of the Bogor Regency HSPK. Some of price obtained from the catalogue in website and from the report. HSPK that used for calculation can be seen in the **Appendix VI** This text provides a detailed account of the financial expenses associated with the construction of a rainwater harvesting system at the Al Kahfi Islamic Boarding School in Bogor Regency. The following table are the details of cost budget plan.

Table 4. 41 Cost Budget Plan of Guter PVC 6 Inches Installation

No	Description	Unit	Coefficient	Unit Price (Rp)	Item Price (Rp)	Total (Rp)
A	Manpower					
	Worker	people/day	0.256	130,000.00	33,280.00	39,480,064.00
	Plumber	people/day	0.128	104,000.00	13,312.00	15,792,025.60
	Foreman	people/day	0.026	207,000.00	5,382.00	6,384,666.60
Total						61,656,756.20
B	Gutter PVC (6 inches)	m	1	17,087.50	17,087.50	20,270,901.25
Total						20,270,901.25
C	Equipment					
Total						-
D	Total (A+B+C)					81,927,657.45
E	Overhead & profit	10% x D				8,192,765.75
F	Unit Price of Work (D+E)					90,120,423.20
	Rounding					90,150,000.00

Table 4. 42 Cost Budget Plan of Guter PVC 8 Inches Installation

No	Description	Unit	Coefficient	Unit Price (Rp)	Item Price (Rp)	Total (Rp)
A	Manpower					
	Worker	people/day	0.256	130,000.00	33,280.00	1,850,368.00
	Plumber	people/day	0.128	104,000.00	13,312.00	740,147.20
	Foreman	people/day	0.026	207,000.00	5,382.00	299,239.20
Total						2,889,754.40
B	Gutter PVC (8 inches)	m	1	25,362.50	25,362.50	1,410,155.00
Total						1,410,155.00
C	Equipment					
Total						-
D	Total (A+B+C)					4,299,909.40

E	Overhead & profit	10% x D				429,990.94
F	Unit Price of Work (D+E)					4,729,900.34
	Rounding					5,750,000.00

Table 4. 43 Cost Budget Plan of PVC Pipe 50 mm Installation

No	Description	Unit	Coefficient	Unit Price	Item Price	Total (Rp)
A	Manpower					
	Worker	people/day	0.256	130,000.00	33,280.00	4,699,136.00
	Plumber	people/day	0.128	104,000.00	13,312.00	1,879,654.40
	Foreman	people/day	0.026	207,000.00	5,382.00	759,938.40
Total						7,338,728.80
B	PVC pipe 50 mm	m	1	27,225.00	27,225.00	3,844,170.00
Total						3,844,170.00
C	Equipment					
Total						-
D	Total (A+B+C)					11,182,898.80
E	Overhead & profit	10% x D				1,118,289.88
F	Unit Price of Work (D+E)					12,301,188.68
	Rounding					12,350,000.00

Table 4. 44 Cost Budget Plan of PVC Pipe 65 mm Installation

No	Description	Unit	Coefficient	Unit Price	Item Price	Total (Rp)
A	Manpower					
	Worker	people/day	0.256	130,000.00	33,280.00	1,374,464.00
	Plumber	people/day	0.128	104,000.00	13,312.00	549,785.60
	Foreman	people/day	0.026	207,000.00	5,382.00	222,276.60
Total						2,146,526.20
B	PVC Pipe 65 mm	m	1	39,675.00	39,675.00	1,638,577.50
Total						1,638,577.50
C	Equipment					
Total						-
D	Total (A+B+C)					3,785,103.70
E	Overhead & profit	10% x D				378,510.37
F	Unit Price of Work (D+E)					4,163,614.07
	Rounding					4,200,000.00

Table 4. 45 Cost Budget Plan of PVC Pipe 80 mm Installation

No	Description	Unit	Coefficient	Unit Price	Item Price	Total (Rp)
A	Manpower					
	Worker	people/day	0.256	130,000.00	33,280.00	7,268,352.00
	Plumber	people/day	0.128	104,000.00	13,312.00	2,907,340.80
	Overseer	people/day	0.026	207,000.00	5,382.00	1,175,428.80
Total						11,351,121.60
B	PVC pipe 80 mm	m	1	52,000.00	52,000.00	11,356,800.00
Total						11,356,800.00

C	Equipment					
Total						-
D	Total (A+B+C)					22,707,921.60
E	Overhead & profit	10% x D				2,270,792.16
F	Unit Price of Work (D+E)					24,978,713.76
	Rounding					25,000,000.00

Table 4. 46 Cost Budget Plan of PVC Pipe 80 mm Installation

No	Description	Unit	Coefficient	Unit Price	Item Price	Total (Rp)
A	Manpower					
	Worker	people/day	0.256	130,000.00	33,280.00	199,680.00
	Plumber	people/day	0.128	104,000.00	13,312.00	79,872.00
	Overseer	people/day	0.026	207,000.00	5,382.00	32,292.00
Total						311,844.00
B	PVC Pipe 125 mm	m	1	146,625.00	146,625.00	879,750.00
Total						879,750.00
C	Equipment					
Total						-
D	Total (A+B+C)					1,191,594.00
E	Overhead & profit	10% x D				119,159.40
F	Unit Price of Work (D+E)					1,310,753.40
	Rounding					1,350,000.00

Table 4. 47 Cost Budget Plan of PVC Pipe 80 mm Installation

No	Description	Unit	Coefficient	Unit Price (Rp)	Item Price (Rp)	Total (Rp)
A	Manpower					
	Worker	people/day	0.256	130,000.00	33,280.00	2,349,568.00
	Plumber	people/day	0.128	104,000.00	13,312.00	79,872.00
	Overseer	people/day	0.026	207,000.00	5,382.00	32,292.00
Total						2,461,732.00
B	PVC pipe 100 mm	m	1	92,575.00	92,575.00	555,450.00
Total						555,450.00
C	Equipment					
Total						-
D	Total (A+B+C)					3,017,182.00
E	Overhead & profit	10% x D				301,718.20
F	Unit Price of Work (D+E)					3,318,900.20
	Rounding					3,350,000.00

The following is a cost estimate for acquiring pipe accessories.

Table 4. 48 Cost Budget Plan of Pipe Accessories Procurement

No	Material	Demand	Unit Price	Total Price
1	Gutter joint (6 inches)	324	Rp 2,050.00	Rp 664,200.00
2	Gutter joint (8 inches)	15	Rp 3,665.00	Rp 54,975.00
3	Gutter bracket (6 inches)	324	Rp 4,410.00	Rp 1,428,840.00
4	Gutter bracket (8 inches)	70	Rp 6,965.00	Rp 484,067.50
5	Pipe filter hub (50 mm)	15	Rp 5,500.00	Rp 82,500.00
6	Pipe filter hub (65 mm)	4	Rp 6,000.00	Rp 24,000.00
7	Gutter Angle (6 inches)	36	Rp 7,840.00	Rp 282,240.00
8	Gutter Angle (8 inches)	7	Rp 13,580.00	Rp 95,060.00
9	Ball valve (2 inches)	45	Rp 55,000.00	Rp 2,475,000.00
10	Ball valve (3 inches)	12	Rp 195,000.00	Rp 2,340,000.00
11	Reducer (3" x 2")	14	Rp 16,000.00	Rp 224,000.00
12	Faucet socket (1/2 x 2")	38	Rp 13,500.00	Rp 513,000.00
13	Gutter stop end (6 inches)	36	Rp 2,045.00	Rp 73,620.00
14	Gutter stop end (8 inches)	2	Rp 4,185.00	Rp 8,370.00
15	Gutter outlet (6 inches)	18	Rp 13,125.00	Rp 236,250.00
16	Gutter outlet (8 inches)	1	Rp 23,260.00	Rp 23,260.00
17	Pipe Clamps (50 mm)	285	Rp 1,450.00	Rp 413,250.00
18	Pipe Clamps (65 mm)	83	Rp 2,900.00	Rp 240,700.00
19	Elbows AW 45° 2 inches	84	Rp 15,885.00	Rp 1,334,340.00
20	Elbows AW 45° 3 inches	24	Rp 58,000.00	Rp 1,392,000.00
21	Reducer knee (2" x 4")	22	Rp 25,800.00	Rp 567,600.00
22	Tee pipe	57	Rp 13,500.00	Rp 769,500.00
23	Venturi Pipe	19	Rp 25,500.00	Rp 484,500.00
24	First Flush Diverter Kit	19	Rp 832,940.00	Rp 15,825,860.00
Total				**Rp 30,037,133**

Next is the cost estimation of unit treatment which functions can be used to purify rainwater for consumption. The following is a cost estimate for acquiring two units for treatment, namely single media filter and ozone generator.

Table 4. 49 Cost Budget Plan of Unit treatment

No	Material	Demand	Unit Price	Total
1	Single Media Filter	19	Rp 2,305,000.00	Rp 43,795,000.00
2	Ozone Generator	19	Rp 1,522,300.00	Rp 28,923,700.00

Next is estimation cost of pump from reservoir tank to the filter and from ground reservoir to the water tap existing. Below is the table shown the cost estimation of the pump

Table 4. 50 Cost Budget Plan of Water Pump

No	Material	Demand	Unit Price	Total
1	Pump	19	Rp 1,350,000.00	Rp 25,650,000.00
2	Shallow well pump	19	Rp 1,350,000.00	Rp 25,650,000.00
Total				Rp 51,300,000.00

Rainwater storage utilizes reservoirs that are readily available in the market, hence the size and price conform to the existing market standards. **Table 4. 51** Below is the table shown the cost estimation of the reservoir tank.

Table 4. 51 Cost Budget Plan of Reservoir Tank

Building	Capacity (L)	Reservoir Tank Capacity	Number of Tank	Unit Price	Total
A	12,000	6,000	2	Rp 10,717,000.00	Rp 21,434,000.00
B	8,000	8,000	1	Rp 18,765,000.00	Rp 18,765,000.00
C	10,000	5,000	2	Rp 6,250,000.00	Rp 12,500,000.00
D	3,000	3,000	1	Rp 4,900,000.00	Rp 4,900,000.00
E	11,000	5,500	2	Rp 7,523,010.00	Rp 15,046,020.00
G	15,000	5,000	3	Rp 6,250,000.00	Rp 18,750,000.00
H	8,000	8,000	1	Rp 18,765,000.00	Rp 18,765,000.00
I	5,000	5,000	1	Rp 6,250,000.00	Rp 6,250,000.00
K	4,000	4,000	1	Rp 5,000,000.00	Rp 5,000,000.00
L	4,000	4,000	1	Rp 5,000,000.00	Rp 5,000,000.00
M	4,000	4,000	1	Rp 5,000,000.00	Rp 5,000,000.00
N	11,000	5,500	2	Rp 7,523,010.00	Rp 15,046,020.00
O	10,000	5,000	2	Rp 6,250,000.00	Rp 12,500,000.00
P	5,000	5,000	1	Rp 6,250,000.00	Rp 6,250,000.00
Q	10,000	5,000	2	Rp 6,250,000.00	Rp 12,500,000.00
R	5,000	5,000	1	Rp 6,250,000.00	Rp 6,250,000.00
S	5,000	5,000	1	Rp 6,250,000.00	Rp 6,250,000.00
T	5,000	5,000	1	Rp 6,250,000.00	Rp 6,250,000.00
V	3,000	3,000	1	Rp 4,900,000.00	Rp 4,900,000.00
Total					Rp 201,356,040.00

The cost budget plan for constructing a ground reservoir as the will be explained based on the specific sort of work.

1. Soil Excavation Work

Below is an itemised breakdown of the expenses associated with excavating soil for each building. The total cost is subsequently determined using the estimated excavation volume as the unit price is already known.

Table 4. 52 Cost Budget Plan of Soil Excavation for each Building

Building	Soil Excavation		
	Volume of Excavation	Unit Price/m³	Total
A	20.24	Rp 154,000.00	Rp 3,116,960.00

Building	Soil Excavation		
	Volume of Excavation	Unit Price/m³	Total
B	15.18	Rp 154,000.00	Rp 2,337,720.00
C	20.24	Rp 154,000.00	Rp 3,116,960.00
D	10.12	Rp 154,000.00	Rp 1,558,480.00
E	17.67	Rp 154,000.00	Rp 2,721,418.33
G	20.24	Rp 154,000.00	Rp 3,116,960.00
H	15.18	Rp 154,000.00	Rp 2,337,720.00
I	10.12	Rp 154,000.00	Rp 1,558,480.00
K	10.12	Rp 154,000.00	Rp 1,558,480.00
L	15.18	Rp 154,000.00	Rp 2,337,720.00
M	5.06	Rp 154,000.00	Rp 779,240.00
N	30.36	Rp 154,000.00	Rp 4,675,440.00
O	30.36	Rp 154,000.00	Rp 4,675,440.00
P	10.12	Rp 154,000.00	Rp 1,558,480.00
Q	15.18	Rp 154,000.00	Rp 2,337,720.00
R	10.12	Rp 154,000.00	Rp 1,558,480.00
S	10.12	Rp 154,000.00	Rp 1,558,480.00
T	10.12	Rp 154,000.00	Rp 1,558,480.00
V	10.12	Rp 154,000.00	Rp 1,558,480.00

2. Sand Backfill Work

Below is an itemised breakdown of the expenses associated with sand backfill for each building. The total cost is subsequently determined using the estimated excavation volume as the unit price is already known.

Table 4. 53 Cost Budget Plan of Sand Backfill

Building	Sand Backfill (m³)		
	Volume of Sand Backfill (m³)	Unit Price/m³	Total
A	0.60	Rp 337,027.00	Rp 202,216.20
B	0.45	Rp 337,027.00	Rp 151,662.15
C	0.60	Rp 337,027.00	Rp 202,216.20
D	0.30	Rp 337,027.00	Rp 101,108.10
E	0.75	Rp 337,027.00	Rp 252,770.25
G	0.60	Rp 337,027.00	Rp 202,216.20
H	0.45	Rp 337,027.00	Rp 151,662.15
I	0.30	Rp 337,027.00	Rp 101,108.10
K	0.45	Rp 337,027.00	Rp 151,662.15
L	0.45	Rp 337,027.00	Rp 151,662.15
M	0.15	Rp 337,027.00	Rp 50,554.05
N	0.90	Rp 337,027.00	Rp 303,324.30
O	0.90	Rp 337,027.00	Rp 303,324.30
P	0.30	Rp 337,027.00	Rp 101,108.10
Q	0.45	Rp 337,027.00	Rp 151,662.15
R	0.30	Rp 337,027.00	Rp 101,108.10
S	0.30	Rp 337,027.00	Rp 101,108.10
T	0.30	Rp 337,027.00	Rp 101,108.10
V	0.30	Rp 337,027.00	Rp 101,108.10

3. Concrete Work

Below is an itemised breakdown of the expenses associated with concrete work for each building.

Table 4. 54 Cost Budget Plan of Concrete Work for each Building

Building	Concrete		
	Volume of Concrete (m^3)	Unit Price/m^3	Total
A	3.18	Rp 1,296,000.00	Rp 4,121,280.00
B	2.39	Rp 1,296,000.00	Rp 3,090,960.00
C	3.18	Rp 1,296,000.00	Rp 4,121,280.00
D	1.59	Rp 1,296,000.00	Rp 2,060,640.00
E	2.19	Rp 1,296,000.00	Rp 2,841,173.94
G	3.18	Rp 1,296,000.00	Rp 4,121,280.00
H	2.39	Rp 1,296,000.00	Rp 3,090,960.00
I	1.59	Rp 1,296,000.00	Rp 2,060,640.00
K	1.59	Rp 1,296,000.00	Rp 2,060,640.00
L	2.39	Rp 1,296,000.00	Rp 3,090,960.00
M	0.79	Rp 1,296,000.00	Rp 1,030,320.00
N	4.77	Rp 1,296,000.00	Rp 6,181,920.00
O	4.77	Rp 1,296,000.00	Rp 6,181,920.00
P	1.59	Rp 1,296,000.00	Rp 2,060,640.00
Q	2.39	Rp 1,296,000.00	Rp 3,090,960.00
R	1.59	Rp 1,296,000.00	Rp 2,060,640.00
S	1.59	Rp 1,296,000.00	Rp 2,060,640.00
T	1.59	Rp 1,296,000.00	Rp 2,060,640.00
V	1.59	Rp 1,296,000.00	Rp 2,060,640.00

4. Wall Formwork

Below is an itemised breakdown of the expenses associated with wall formwork for each building.

Building	Wall Formwork (m^2)		
	Wall Framework Requirements (m^2)	Unit Price/m^2	Total
A	20.00	Rp730,092.00	Rp14,601,840.00
B	16.00	Rp730,092.00	Rp11,681,472.00
C	20.00	Rp730,092.00	Rp14,601,840.00
D	12.00	Rp730,092.00	Rp8,761,104.00
E	17.89	Rp730,092.00	Rp13,060,282.73
G	20.00	Rp730,092.00	Rp14,601,840.00
H	16.00	Rp730,092.00	Rp11,681,472.00
I	12.00	Rp730,092.00	Rp8,761,104.00
K	12.00	Rp730,092.00	Rp8,761,104.00
L	16.00	Rp730,092.00	Rp11,681,472.00
M	8.00	Rp730,092.00	Rp5,840,736.00
N	28.00	Rp730,092.00	Rp20,442,576.00
O	28.00	Rp730,092.00	Rp20,442,576.00
P	12.00	Rp730,092.00	Rp8,761,104.00
Q	16.00	Rp730,092.00	Rp11,681,472.00
R	12.00	Rp730,092.00	Rp8,761,104.00
S	12.00	Rp730,092.00	Rp8,761,104.00
T	12.00	Rp730,092.00	Rp8,761,104.00

Building	Wall Formwork (m²)		
	Wall Framework Requirements (m²)	Unit Price/m²	Total
V	12.00	Rp730,092.00	Rp8,761,104.00

5. **Cover Plate Work**

Below is an itemised breakdown of the expenses associated with cover plate work for each building.

Table 4. 55 Cost Budget Plan of Cover Plate Work for each Building

Building	Cover Plate (m³)		
	Cover Plate (m²)	Unit Price/m²	Total
A	0.78	Rp 123,225.00	Rp 96,670.01
B	0.59	Rp 123,225.00	Rp 72,641.14
C	0.78	Rp 123,225.00	Rp 96,670.01
D	0.39	Rp 123,225.00	Rp 48,612.26
E	0.91	Rp 123,225.00	Rp 112,226.69
G	0.78	Rp 123,225.00	Rp 96,670.01
H	0.59	Rp 123,225.00	Rp 72,641.14
I	0.39	Rp 123,225.00	Rp 48,612.26
K	0.39	Rp 123,225.00	Rp 48,612.26
L	0.59	Rp 123,225.00	Rp 72,641.14
M	0.20	Rp 123,225.00	Rp 24,583.39
N	1.17	Rp 123,225.00	Rp 144,727.76
O	1.17	Rp 123,225.00	Rp 144,727.76
P	0.39	Rp 123,225.00	Rp 48,612.26
Q	0.59	Rp 123,225.00	Rp 72,641.14
R	0.39	Rp 123,225.00	Rp 48,612.26
S	0.39	Rp 123,225.00	Rp 48,612.26
T	0.39	Rp 123,225.00	Rp 48,612.26
V	0.39	Rp 123,225.00	Rp 48,612.26

6. **Ceramic Tiles Work**

Below is an itemised breakdown of the expenses associated with ceramic tiles work for each building.

Table 4. 56 Cost Budget Plan of Ceramic Tiles Work for each Building

Building	Ceramic Tiles 30x 30 (m²)		
	Ceramic Tiles 30x 30 (m²)	Unit Price/m²	Total
A	24.00	Rp 416,482.00	Rp 9,995,568.00
B	19.00	Rp 416,482.00	Rp 7,913,158.00
C	24.00	Rp 416,482.00	Rp 9,995,568.00
D	14.00	Rp 416,482.00	Rp 5,830,748.00
E	22.89	Rp 416,482.00	Rp 9,532,666.51
G	24.00	Rp 416,482.00	Rp 9,995,568.00
H	19.00	Rp 416,482.00	Rp 7,913,158.00

Building	Ceramic Tiles 30x 30 (m²)		
	Ceramic Tiles 30x 30 (m²)	Unit Price/m²	Total
I	14.00	Rp 416,482.00	Rp 5,830,748.00
K	14.00	Rp 416,482.00	Rp 5,830,748.00
L	19.00	Rp 416,482.00	Rp 7,913,158.00
M	9.00	Rp 416,482.00	Rp 3,748,338.00
N	34.00	Rp 416,482.00	Rp 14,160,388.00
O	34.00	Rp 416,482.00	Rp 14,160,388.00
P	14.00	Rp 416,482.00	Rp 5,830,748.00
Q	19.00	Rp 416,482.00	Rp 7,913,158.00
R	14.00	Rp 416,482.00	Rp 5,830,748.00
S	14.00	Rp 416,482.00	Rp 5,830,748.00
T	14.00	Rp 416,482.00	Rp 5,830,748.00
V	14.00	Rp 416,482.00	Rp 5,830,748.00

4.13.3 Recapitulation of Cost Budget Plan

The recapitulation will be categorised rainwater harvesting systems for each individual Islamic boarding school building and work type helping the prioritisation of construction projects. This is a summary of the rainwater harvesting system implemented at the Al Kahfi Islamic Boarding School in Bogor Regency.

Table 4. 57 Recapitulation of Cost Budget Plan of Rainwater Harvesting in Al Kahfi Islamic Boarding School

Total Cost	
Rain Harvesting System of Building A	Rp 53,379,129.67
Rain Harvesting System of Building B	Rp 42,390,601.00
Rain Harvesting System of Building C	Rp 60,439,287.17
Rain Harvesting System of Building D	Rp 38,952,498.34
Rain Harvesting System of Building E	Rp 70,491,045.11
Rain Harvesting System of Building G	Rp 81,320,793.55
Rain Harvesting System of Building H	Rp 63,155,809.88
Rain Harvesting System of Building I	Rp 45,980,275.59
Rain Harvesting System of Building K	Rp 41,043,703.04
Rain Harvesting System of Building L	Rp 52,580,591.13
Rain Harvesting System of Building M	Rp 29,392,545.55
Rain Harvesting System of Building N	Rp 80,431,792.25
Rain Harvesting System of Building O	Rp 92,151,767.50
Rain Harvesting System of Building P	Rp 43,815,518.59
Rain Harvesting System of Building Q	Rp 47,710,214.13
Rain Harvesting System of Building R	Rp 32,953,024.59
Rain Harvesting System of Building S	Rp 29,418,548.59
Rain Harvesting System of Building T	Rp 34,708,999.09
Rain Harvesting System of Building V	Rp 31,719,021.09
Total	**Rp 972,035,165.90**
PPN 11%	**Rp 106,923,868.25**
Total	**Rp 1,078,959,034.15**

Total Cost	
Rounding	**Rp 1,079,000,000.00**
One Billion Seventy-Nine Million Rupiah	

The sum of the total costs and a tax rate of 11% as defined in Law no. 7 of 2021, which relates to the harmonization of tax regulations.

Table 4. 58 Recapitulation of Cost Budget Plan of Rainwater Harvesting Per Type of Work

Installation of Gutter and Pipe	Rp 142,150,000.00
Accessories Procurement	Rp 30,037,132.50
Unit Treatment	Rp 72,718,700.00
Pump Procurement	Rp 51,300,000.00
Reservoir tank	Rp 197,069,240.00
Soil Excavation	Rp 44,170,924.54
Sand Backfill	Rp 5,216,305.05
Concrete	Rp 57,472,292.30
Wall FormWork	Rp 220,617,732.72
Cover Plate	Rp 1,395,738.29
Ceramic Tiles	Rp 149,887,100.51
Total	**Rp 972,035,165.9**
PPN 11%	**Rp 106,923,868.25**
Total	**Rp 1,078,959,034.16**
Rounding	**Rp 1,079,000,000.00**
One Billion Seventy-Nine Million Rupiah	

4.17 Procedures for Maintaining a Rainwater Harvesting System

It is essential to regularly maintain the rainwater harvesting system to ensure its best performance. Below is a protocol for maintaining a rainwater harvesting system.

1. Remove sediments from the first flush diverter by opening the socket and cleaning it
2. Regularly maintain the gutters and the gutter filters by removing any debris such as twigs, leaves, or other substances that may affect the quality of the water.
3. During the dry season, close the gate valve to the filter.
4. Replace the activated carbon filter media annually.
5. Periodically, cleanse the reservoir tank at a minimum interval of 6 months employing the subsequent procedure
   - Water being pumped out.
   - Workers access the reservoir through the manhole to clean the walls and floor of reservoir.
   - Remove the accumulated sediment from the reservoir by open the bottom tap
   - Refill the reservoir.
6. To rid the media of particles, backwash the water filter. When the arrow indicates "backwash," turn the lever to cause water to automatically enter from the bottom and exit upward into the backwash water drainpipe.

CHAPTER V

CONCLUSION AND SUGGESTION

5.1 Conclusion

The rainwater collecting system of the Al Kahfi Islamic Boarding School in Bogor Regency was planned, and the following conclusions were drawn.

1. The laboratory tests showed that the rainwater collected from various rainwater gutters consistently surpassed the drinking water quality limits for both *E. Coli* and total coliform parameters. At certain intervals, it exhibits low pH levels, high turbidity, coloration, and elevated levels of manganese and chromium. The rain at the Al Kahfi Islamic boarding school is measured in terms of rain intensity. It was observed that the rain intensity in the male student area ranged from 84.1 mm/hour to 179.73 mm/hour. The range for the female student area is 59.11 mm/hour to 160,59 mm/hour. The estimated percentage of rainwater that can be used as an alternative drinking water for buildings A, B, C, D, E, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, and V based on period of one decade are, 87%, 68%, 77%, 47%, 60%, 61%, 45%, 44%, 51%, 46%, 68%, 54%, 53%, 62%, 113%, 82%, 82%, 94%, and 50% respectively.
2. A rainwater harvesting system is proposed for all dormitory buildings, except Usaid, Maria Qibtiyah, Aisyah, and Khodijah. The rainwater collected is stored in tanks with varying capacities based on the intensity of the rain. The prepared reservoir has a storage capacites of 12 m^3, 8 m^3, 10 m^3, 3 m^3, 11 m^3, 15 m^3, 8 m^3 and 5 m^3 respectively for dormitory buildings A, B, C, D, E, G, H, and I. while for buildings K, L, M, N, O, P, Q, R, S, T, and V respectively 4 m^3, 4 m^3, 4 m^3, 11 m^3 ,10 m^3, 5 m^3, 10 m^3, 5 m^3, 5 m^3, 5 m^3 and 3 m^3. Afterward, the water undergoes pumping and is subjected to treatment using an active carbon filter and ozonation. Subsequently, the drinking water is briefly kept in a ground reservoir prior to being sent to the tap.
3. The total cost estimation for designing a rainwater harvesting system at Al Kahfi Islamic Boarding School is IDR 1,079,000,000.00

5.2 Suggestion

The following are recommendations for improving the rainwater harvesting system at the Al Kahfi Islamic Boarding School in Bogor.

1. For researchers to obtain accurate findings, it is necessary to collect rainwater samples on a minimum of three times.
2. Efforts have started to implement rainwater harvesting devices in various locations to maximise the utilisation of rainfall.

REFERENCES

Abdulla, F. A., & Al-Shareef, A. W. (2009). Roof rainwater harvesting systems for household water supply in Jordan. *Desalination*, *243*(1), 195–207. https://doi.org/10.1016/j.desal.2008.05.013

Adewumi, B., Familusi, A., Olusami, J., & Ogundare, D. (2017, September 1). *Construction of Charcoal Filter for Rainwater Treatment*.

Anchan, S. S., & Shiva Prasad, H. C. (2021). Feasibility of roof top rainwater harvesting potential—A case study of South Indian University. *Cleaner Engineering and Technology*, *4*, 100206. https://doi.org/10.1016/j.clet.2021.100206

Andini, A. (2017). Analisa Kadar Kromium VI [Cr (VI)] Air di Kecamatan Tanggulangin, Sidoarjo. *Jurnal SainHealth*, *1*(2), 55. https://doi.org/10.51804/jsh.v1i2.105.55-58

Arianti, I., Soemarno, Aw, H., & R, S. (2021). *Rainfall estimation by using Thiessen Polygons, Inverse Distance Weighted, Spline, And Kriging Methods: A case study in Pontianak, West Kalimantan*. http://repository.polnep.ac.id/xmlui/handle/123456789/1972

Ariyani, S., Asmawit, Utomo, P., & Cahyanto, H. (2020). PENINGKATAN KUALITAS KEASAMAN (pH) PADA SUMBER AIR UNTUK INDUSTRI AIR MINERAL DENGAN METODE PENYARINGAN. *JURNAL BORNEO AKCAYA*, *6*, 33–42. https://doi.org/10.51266/borneoakcaya.v6i1.158

Asnur, P. (2021). EVALUASI KEMAMPUAN DAN KESESUAIAN LAHAN PERTANIAN DI KABUPATEN BOGOR. *UG Journal*, *14*(2), Article 2. https://ejournal.gunadarma.ac.id/index.php/ugjournal/article/view/3553

Badan Standarisasi Nasional. (n.d.). *Sni 03 7065 2005*. Scribd. Retrieved December 15, 2023, from https://id.scribd.com/document/361007704/sni-03-7065-2005-plambing-pdf-R1

Badan Standarisasi Nasional. (1991). *SNI 06-2412-1991*. https://pesta.bsn.go.id/produk/detail/2780-sni06-2412-1991

Bayable, A., Desta, A., & Fassil, A. (2020). Evaluating the efficacy of household filters used for the removal of bacterial contaminants from drinking water. *African Journal of Microbiology Research*, *14*, 273–279. https://doi.org/10.5897/AJMR2020.9344

Bhagat, N. (2017). Flood frequency analysis using Gumbel's Distribution Method: A case study of Lower Mahi Basin, India. *Ocean Development and International Law*, *6*, 51–54. https://doi.org/10.11648/j.wros.20170604.11

bhakti. (2012, April 2). Efisiensi Ozonisasi Air Tanah Dalam Proses Desinfeksi. *Karya Tulis Ilmiah Itenas*. https://lib.itenas.ac.id/kti/?p=565

Bullo, T., & Bayisa, Y. (2022). *OPTIMIZING THE REMOVAL EFFICIENCY OF CHROMIUM FROM TANNING PLANT EFFLUENT BY ADSORPTION METHOD WITH ACTIVATED CARBON CHAT STEMS (CATHA EDULIS) USING RESPONSE SURFACE METHODOLOGY*. *6*, 26–32. https://doi.org/10.26480/wcm.01.2022.26.32

Campisano, A., Butler, D., Ward, S., Burns, M. J., Friedler, E., DeBusk, K., Fisher-Jeffes, L. N., Ghisi, E., Rahman, A., Furumai, H., & Han, M. (2017). Urban rainwater harvesting systems: Research, implementation and future perspectives. *Water Research*, *115*, 195–209. https://doi.org/10.1016/j.watres.2017.02.056

Dąbrowska, L. (2021). The Effect of Ozonation, Coagulation and Adsorption on Natural Organic Matter Removal. *Journal of Ecological Engineering*, *22*(9), 216–223. https://doi.org/10.12911/22998993/141377

Dianawati, R., Wahyuningsih, N., & Nur, M. (2018). Treatment of hospital waste water by ozone technology. *Journal of Physics: Conference Series*, *1025*, 012013. https://doi.org/10.1088/1742-6596/1025/1/012013 du Prel, J.-B., Hommel, G., Röhrig, B., & Blettner, M. (2009). Confidence Interval or P-Value? *Deutsches Ärzteblatt International*, *106*(19), 335–339. https://doi.org/10.3238/arztebl.2009.0335

Erabee, I. K., & Ethaib, S. M. (2018). Performane of Activated Carbon Adsorption in Removing of Organic Pollutants from River Water. *International Journal of Engineering & Technology*, *7*(4.20), Article 4.20. https://doi.org/10.14419/ijet.v7i4.20.26134

Ertop, H., Kocięcka, J., Atilgan, A., Liberacki, D., Niemiec, M., & Rolbiecki, R. (2023). The importance of rainwater harvesting and its usage possibilities: Antalya example (Turkey). *Water*, *15*(12), Article 12. https://doi.org/10.3390/w15122194

Faktor Keamanan(Safety Factor) Dalam Perancangan Elemen Mesin | Libratama.com. (n.d.). Retrieved July 25, 2024, from https://libratama.com/faktor-keamanansafety-factor-dalam-perancangan-elemen-mesin/

Fathar, I. R., Hamzah, A. H. P., & Nurhasanah. (2022). *Pemanfaatan Ozon Sebagai Teknologi Berkelanjutan Daur Ulang Air Limbah Domestik Hotel X Lembang | INSOLOGI: Jurnal Sains dan Teknologi*. https://journal.literasisains.id/index.php/insologi/article/view/234

Febriyana, N. A., & Masduqi, A. (2020). Aeration—Advanced Filtration (AAF) Treatment for reducing iron and chloride in natural groundwater. *IPTEK The Journal for Technology and Science*, *31*(2), Article 2. https://doi.org/10.12962/j20882033.v31i2.5581

Förster, J. (1998). The influence of location and season on the concentrations of macroions and organic trace pollutants in roof runoff. *Water Science and Technology*, *38*(10), 83–90. https://doi.org/10.1016/S0273-1223(98)00736-7

Hatt, J., Germain, E., & Judd, S. (2013). Granular activated carbon for removal of organic matter and turbidity from secondary wastewater. *Water Science and Technology : A Journal of the International Association on Water Pollution Research*, *67*, 846–853. https://doi.org/10.2166/wst.2012.644

Herlambang, A. (2018). Teknologi penyediaan air minum untuk keadaan tanggap darurat. *Jurnal Air Indonesia*, *6*(1). https://doi.org/10.29122/jai.v6i1.2455

Hossen, A., Ahmed, F., Saha, S., & Mondal, M. (2023). Advantages of ozone disinfection method for water purification over chlorine disinfection. *Natural Resources Conservation and Research*, *6*, 2090. https://doi.org/10.24294/nrcr.v6i2.2090

Inglezakis, V. J., Poulopoulos, S. G., Arkhangelsky, E., Zorpas, A. A., & Menegaki, A. N. (2016). Chapter 3—Aquatic environment. In S. G. Poulopoulos & V. J. Inglezakis (Eds.), *Environment and Development* (pp. 137–212). Elsevier. https://doi.org/10.1016/B978-0-444-62733-9.00003-4

Ismail, A., Harmuni, H., & Mohd, R. R. M. A. Z. (2017). Removal of iron and manganese using granular activated carbon and zeolite in artificial barrier of riverbank filtration. *AIP Conference Proceedings*, *1835*(1), 020056. https://doi.org/10.1063/1.4983796

Jamalinezhad, M., Hassani, A. H., Borghei, M., & Amin, M. M. (2021). Performance evaluation of ultraviolet radiation and ozone disinfection for municipal secondary effluent reuse (Case study in Isfahan North wastewater treatment plant). *Desalination and Water Treatment*, *223*, 105–113. https://doi.org/10.5004/dwt.2021.27061

Jiang, J.-Q. (2015). The role of coagulation in water treatment. *Current Opinion in Chemical Engineering*, *8*, 36–44. https://doi.org/10.1016/j.coche.2015.01.008

Kepmenpupr. (2001). *2001-Kepmenpupr nomor 534/KPTS/M/2001*. Google Docs. https://drive.google.com/file/d/1SPR5dKJAAKsB_Rdyp98MFL7Y_0yGZoh8/preview?usp=embed_facebook

Kevin, A., Adhani, R., & Hamdani, R. (2023). HUBUNGAN KADAR pH, MAGNESIUM, FLUOR DAN FERRUM AIR SUNGAI KONSUMSI TERHADAP INDEKS KARIES. *Dentin*, *7*(3), Article 3. https://doi.org/10.20527/dentin.v7i3.10749

Lestari, R., Ramadhani, R., Sherawali, S., & Yudha, A. T. R. (2021). Air dan dampak kelangkaannya bagi perekonomian masyarakat urban: Studi pustaka Pulau Jawa. *OECONOMICUS Journal of Economics*, *6*, 38–48. https://doi.org/10.15642/oje.2021.6.1.38-48

Mohammed, J., Jaafar, N., Poh, L., Evuti, A., & Mohammed Evuti, A. (2013). Removal of Colour from Waste Water Using Coconut Shell Activated Carbon (CSAC) and Commercial Activated Carbon (CAC). *Jurnal Teknologi*, *60*, 15–19. https://doi.org/10.11113/jt.v60.1387

Nabavi, E., Niavol, K. P., Dezvareh, G. A., & Darban, A. K. (2023). *(PDF) A combined treatment system of O3/UV oxidation and activated carbon adsorption: Emerging contaminants in hospital wastewater*. https://www.researchgate.net/publication/369275016_A_combined_treatment_system_of_O3UV_oxidation_and_activated_carbon_adsorption_emerging_contaminants_in_hospital_wastewater

newsunair. (2021, May 3). Analisis Logam Berat (Kadmium, Kromium, Timbal, Mangan, Dan Seng) dalam Air Sumur. *Unair News*. https://news.unair.ac.id/2021/05/03/analisis-logam-berat-kadmium-kromium-timbal-mangan-dan-seng-dalam-air-sumur/?lang=id

Nurhijriah, L., Ruhiyat, Y., Saefullah, A., & Rostikawati, D. A. (2022). Pemetaan distribusi curah hujan rata-rata menggunakan metode isohyet di wilayah Kabupaten Tangerang. *Newton-Maxwell Journal of Physics*, *3*(2), Article 2. https://doi.org/10.33369/nmj.v3i2.23100

Raimondi, A., Quinn, R., Abhijith, G. R., Becciu, G., & Ostfeld, A. (2023). Rainwater harvesting and treatment: State of the art and perspectives. *Water*, *15*(8), Article 8. https://doi.org/10.3390/w15081518

Rakhecha, P., & Singh, V. (2009). Applied hydrometeorology. In *Acoustical Physics*. https://doi.org/10.1007/978-1-4020-9844-4

Rekhate, C. V., & Srivastava, J. K. (2021). Effectiveness of O3/Fe2+/H2O2 process for detoxification of heavy metals in municipal wastewater by using RSM. *Chemical Engineering and Processing - Process Intensification*, *165*, 108442. https://doi.org/10.1016/j.cep.2021.108442

Rengganis, H., & Harnandi, D. (2011). Penilaian kondisi air tanah dan upaya konservasi di wilayah cekungan air tanah Bogor. *JURNAL TEKNIK HIDRAULIK*, *2*(2), 165–178.

Sajjad, M. M., Wang, J., Afzal, Z., Hussain, S., Siddique, A., Khan, R., Ali, M., & Iqbal, J. (2023). Assessing the impacts of groundwater depletion and aquifer degradation on land subsidence in Lahore, Pakistan: A PS-InSAR approach for sustainable urban development. *Remote Sensing*, *15*(22), Article 22. https://doi.org/10.3390/rs15225418

Singh, D., Choudhary, M., Meena, M., & Kumar, C. (2019). Rain water arhvesting for food and livelihood security: A case study from Pali, India. *Open Agriculture*, *4*, 767–777. https://doi.org/10.1515/opag-2019-0071

Suripin. (2004). *Sistem Drainase Perkotaan yang Berkelanjutan*. ANDI.

Tewalt, S., Sato, M., Dulong, F., Neuzil, S., Kolker, A., & Dennen, K. (2005). Use of Ozone to Remediate Manganese from Coal Mine Drainage Waters. *22nd American Society of Mining and Reclamation Annual National Conference 2005*, *2*. https://doi.org/10.21000/JASMR05011166

Wang, W., Chen, L., & Xu, C.-Y. (2021). Hydrological modeling in water cycle processes. *Water*, *13*(14), Article 14. https://doi.org/10.3390/w13141882

Wang, W., Li, C., Dong, Y., Chen, Z., Yang, L., Wei, Y., Wu, K., Zhang, H., & Tian, Y. (2022). Removal Performances of Turbidity, Organics, and NH4+-N in a Modified Settling

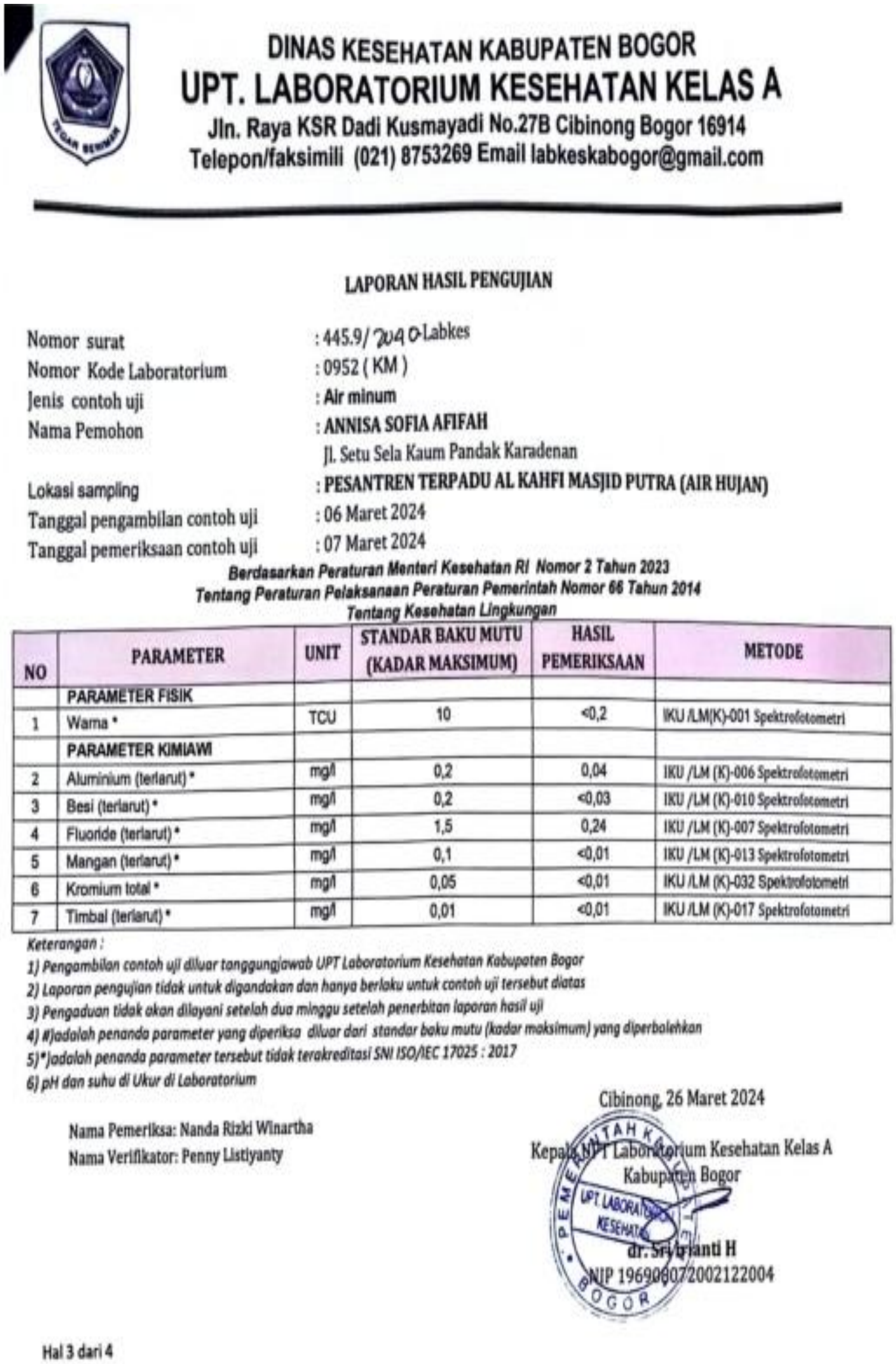
Tank with Rotating Biological Discs Used for Enhancing Drinking Water Purification. *Water*, *14*(24), Article 24. https://doi.org/10.3390/w14244066

Wigati, R., Mina, E., Kusuma, R. I., Kuncoro, H. B. B., Fathonah, W., & Ruyani, N. R. (2022). Implementasi pemanenan air hujan (rainwater harvesting) pada masa pandemi Covid-19 di Kota Serang. *Dharmakarya : Jurnal Aplikasi Ipteks Untuk Masyarakat*, *11*(1), Article 1. https://doi.org/10.24198/dharmakarya.v11i1.37903

Zhu, L., Gong, H., Li, X., Wang, R., Chen, B., Dai, Z., & Teatini, P. (2015). Land subsidence due to groundwater withdrawal in the northern Beijing plain, China. *Engineering Geology*, *193*, 243–255. https://doi.org/10.1016/j.enggeo.2015.04.020

APPENDIX

APPENDIX I Laboratory Test Results



DINAS KESEHATAN KABUPATEN BOGOR
UPT. LABORATORIUM KESEHATAN KELAS A
Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914
Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 2049 -Labkes
Nomor Kode Laboratorium : 0952 (KM)
Jenis contoh uji : Air minum
Nama Pemohon : ANNISA SOFIA AFIFAH
Jl. Setu Sela Kaum Pandak Karadenan
Lokasi sampling : PESANTREN TERPADU AL KAHFI MASJID PUTRA (AIR HUJAN)
Tanggal pengambilan contoh uji : 06 Maret 2024
Tanggal pemeriksaan contoh uji : 07 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023
Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014
Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	<0,2	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,04	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	<0,03	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	0,24	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	<0,01	IKU /LM (K)-013 Spektrofotometri
6	Kromium total *	mg/l	0,05	<0,01	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :
1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor
2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas
3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji
4) #)adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan
5))adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*
6) pH dan suhu di Ukur di Laboratorium

Cibinong, 26 Maret 2024

Nama Pemeriksa: Nanda Rizki Winartha
Nama Verifikator: Penny Listiyanty

Kepala UPT Laboratorium Kesehatan Kelas A
Kabupaten Bogor

dr. Sri Arianti H
NIP 196909072002122004

Hal 3 dari 4

Figure 1 Results of Laboratory Tests for Rainwater from Male's Mosque on Day 1

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN

UPTD Laboratorium Kesehatan Daerah

Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

KAN
Komite Akreditasi Nasional
LP-1382-IDN

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 306/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 277/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Air Hujan Masjid Putra
   d. Tanggal dan waktu pengambilan[1] : 6 Maret 2024 Pkl. 13.18 WIB
   e. Tanggal dan jam penerimaan : 7 Maret 2024 Pkl. 10.33 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 21 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	0,73	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	0,019	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	23[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli*[3]	CFU/100 mL	18[4]	0	SM APHA 23rd Ed. 9222D, 2017

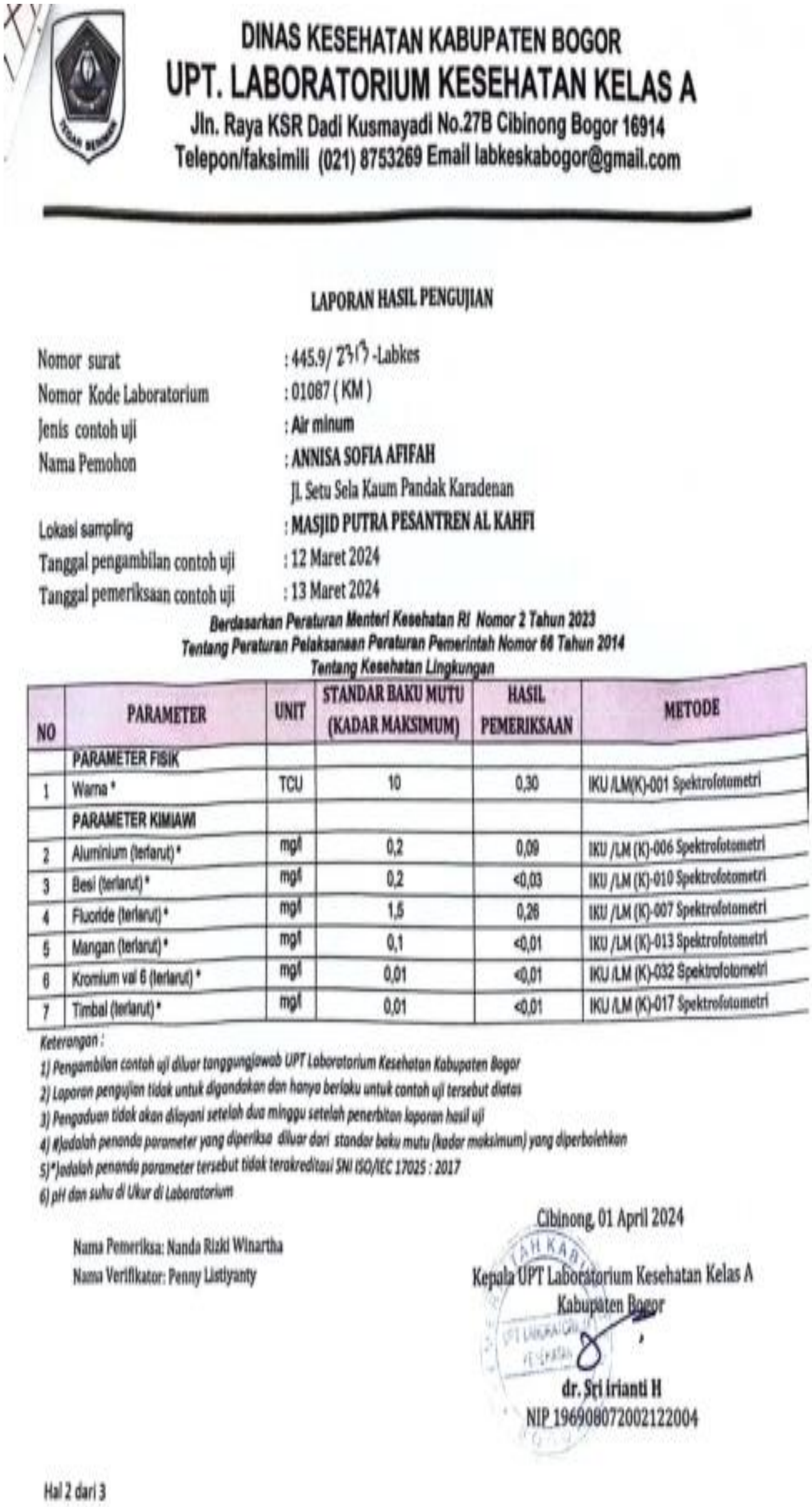
Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan

Bogor, 21 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas, pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 2 Results of Laboratory Tests for Rainwater from Male's Mosque on Day 1


DINAS KESEHATAN KABUPATEN BOGOR
UPT. LABORATORIUM KESEHATAN KELAS A
Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914
Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 2317 -Labkes
Nomor Kode Laboratorium : 01087 (KM)
Jenis contoh uji : Air minum
Nama Pemohon : ANNISA SOFIA AFIFAH
Jl. Setu Sela Kaum Pandak Karadenan
Lokasi sampling : MASJID PUTRA PESANTREN AL KAHFI
Tanggal pengambilan contoh uji : 12 Maret 2024
Tanggal pemeriksaan contoh uji : 13 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023
Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014
Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	0,30	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,09	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	<0,03	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	0,28	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	<0,01	IKU /LM (K)-013 Spektrofotometri
6	Kromium val 6 (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :
1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor
2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas
3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji
4) #adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan
*5) *adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*
6) pH dan suhu di Ukur di Laboratorium

Cibinong, 01 April 2024

Nama Pemeriksa: Nanda Rizki Winartha
Nama Verifikator: Penny Listiyanty

Kepala UPT Laboratorium Kesehatan Kelas A
Kabupaten Bogor

dr. Sri irianti H
NIP 196908072002122004

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Figure 3 Results of Laboratory Tests for Rainwater from Male's Mosque on Day 2

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN
UPTD Laboratorium Kesehatan Daerah
Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

KAN Komite Akreditasi Nasional LP-1362-IDN

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 327/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 298/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Sampel Air Hujan Masjid Putra (Day 2)
   d. Tanggal dan waktu pengambilan[1] : 12 Maret 2024 Pkl. 15.11 WIB
   e. Tanggal dan jam penerimaan : 13 Maret 2024 Pkl. 11.45 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 25 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	0,38	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	0,096	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	184[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli*[3]	CFU/100 mL	140[4]	0	SM APHA 23rd Ed. 9222D, 2017

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan

Bogor, 27 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas. pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 4 Results of Laboratory Tests for Rainwater from Male's Mosque on Day 2

DINAS KESEHATAN KABUPATEN BOGOR
UPT. LABORATORIUM KESEHATAN KELAS A
Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914
Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 2042 Labkes
Nomor Kode Laboratorium : 0905 (KM)
Jenis contoh uji : Air minum
Nama Pemohon : ANNISA SOFIA AFIFAH
Jl. Setu Sela Kaum Pandak Karadenan
Lokasi sampling : PESANTREN TERPADU AL KAHFI (AIR TANAH)
Tanggal pengambilan contoh uji : 04 Maret 2024
Tanggal pemeriksaan contoh uji : 05 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023
Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014
Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	0,20	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,06	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	0,01	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	<0,10	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	0,02	IKU /LM (K)-013 Spektrofotometri
6	Kromium val 6 (Cr^{6+}) (terlarut) *	mg/l	0,01	0,02	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :
1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor
2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas
3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji
4) #)adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan
5))adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*
6) pH dan suhu di Ukur di Laboratorium

Nama Pemeriksa: Nanda Rizki Winartha
Nama Verifikator: Penny Listiyanty

Cibinong, 23 Maret 2024
Kepala UPT Laboratorium Kesehatan Kelas A
Kabupaten Bogor

dr. Sri irianti H
NIP 196908072002122004

Hal 1 dari 2

Figure 5 Results of Laboratory Tests for Groundwater on Day 1

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN
UPTD Laboratorium Kesehatan Daerah
Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 285/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 256/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Air Tanah
   d. Tanggal dan waktu pengambilan[1] : 4 Maret 2024 Pkl. 14.19 WIB
   e. Tanggal dan jam penerimaan : 5 Maret 2024 Pkl. 11.25 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 18 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	0,82	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	<0,005	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	45[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli* [3]	CFU/100 mL	5[4]	0	SM APHA 23rd Ed. 9222D, 2017

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan

Bogor, 20 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas.
pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 6 Results of Laboratory Tests for Groundwater on Day 1

DINAS KESEHATAN KABUPATEN BOGOR
UPT. LABORATORIUM KESEHATAN KELAS A
Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914
Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 2044/Labkes
Nomor Kode Laboratorium : 0917 (KM)
Jenis contoh uji : Air minum
Nama Pemohon : ANNISA SOFIA AFIFAH
Jl. Setu Sela Kaum Pandak Karadenan
Lokasi sampling : PESANTREN TERPADU AL KAHFI (AIR TANAH)
Tanggal pengambilan contoh uji : 05 Maret 2024
Tanggal pemeriksaan contoh uji : 06 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023
Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014
Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	0,30	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,03	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	<0,03	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	0,17	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	<0,01	IKU /LM (K)-013 Spektrofotometri
6	Kromium val 6 (Cr^{6+}) (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :
1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor
2) Laporan pengujian tidak untuk dipandakan dan hanya berlaku untuk contoh uji tersebut diatas
3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji
4) #adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan
*5)*adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*
6) pH dan suhu di Ukur di Laboratorium

Nama Pemeriksa: Nanda Rizki Winartha
Nama Verifikator: Penny Listiyanty

Cibinong, 25 Maret 2024
Kepala UPT Laboratorium Kesehatan Kelas A
Kabupaten Bogor

dr. Sri Irianti H
NIP 196908072002122004

Hal 1 dari 2

Figure 7 Results of Laboratory Tests for Groundwater on Day 2

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN

UPTD Laboratorium Kesehatan Daerah

Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

KAN — Komite Akreditasi Nasional LP-1362-IDN

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 299/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 270/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Air Tanah Day 2
   d. Tanggal dan waktu pengambilan[1] : 5 Maret 2024 Pkl. 16.00 WIB
   e. Tanggal dan jam penerimaan : 6 Maret 2024 Pkl. 10.45 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 20 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	0,15	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	<0,005	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	30[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli*[3]	CFU/100 mL	<1[5]	0	SM APHA 23rd Ed. 9222D, 2017

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan
5) Bakteri *Escherichia Coli* tidak ditemukan dalam 100 mL contoh uji

Bogor, 21 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas.
pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 8 Results of Laboratory Tests for Groundwater on Day 2

DINAS KESEHATAN KABUPATEN BOGOR

UPT. LABORATORIUM KESEHATAN KELAS A

Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914

Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 240Labkes
Nomor Kode Laboratorium : 0953 (KM)
Jenis contoh uji : Air minum
Nama Pemohon : ANNISA SOFIA AFIFAH
Jl. Setu Sela Kaum Pandak Karadenan
Lokasi sampling : PESANTREN TERPADU AL KAHFI ASRAMA PUTRA (AIR HUJAN)
Tanggal pengambilan contoh uji : 06 Maret 2024
Tanggal pemeriksaan contoh uji : 07 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023
Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014
Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	87,00 #	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,04	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	0,10	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	<0,10	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	0,38 #	IKU /LM (K)-013 Spektrofotometri
6	Kromium total *	mg/l	0,05	0,02	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :
1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor
2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas
3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji
4) #adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan
*5)*adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*
6) pH dan suhu di Ukur di Laboratorium

Nama Pemeriksa: Nanda Rizki Winartha
Nama Verifikator: Penny Listiyanty

Cibinong, 26 Maret 2024
Kepala UPT Laboratorium Kesehatan Kelas A
Kabupaten Bogor

PEMERINTAH KABUPATEN BOGOR
UPT LABORATORIUM KESEHATAN

dr. Sri Irianti H
NIP 19[illegible]072002122004

Hal 4 dari 4

Figure 9 Results of Laboratory Tests for Rainwater from Male's Dormitory on Day 1

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN
UPTD Laboratorium Kesehatan Daerah
Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 287/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 258/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Air Hujan Asrama Putra
   d. Tanggal dan waktu pengambilan[1] : 4 Maret 2024 Pkl. 15.13 WIB
   e. Tanggal dan jam penerimaan : 5 Maret 2024 Pkl. 11.25 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 18 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	0,35	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	<0,005	3	SNI 06 6989.9-2004

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)

Bogor, 20 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas.
pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 10 Results of Laboratory Tests for Rainwater from Male's Dormitory on Day 1

DINAS KESEHATAN KABUPATEN BOGOR

UPT. LABORATORIUM KESEHATAN KELAS A

Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914

Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 23 12-Labkes

Nomor Kode Laboratorium : 01088 (KM)

Jenis contoh uji : Air minum

Nama Pemohon : ANNISA SOFIA AFIFAH

Jl. Setu Sela Kaum Pandak Karadenan

Lokasi sampling : ASRAMA PUTRA PESANTREN AL KAHFI

Tanggal pengambilan contoh uji : 12 Maret 2024

Tanggal pemeriksaan contoh uji : 13 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023

Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014

Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Wama *	TCU	10	79,00 #	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,06	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	<0,03	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	0,04	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	0,20 #	IKU /LM (K)-013 Spektrofotometri
6	Kromium val 6 (terlarut) *	mg/l	0,01	0,08 #	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :

1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor

2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas

3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji

4) #adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan

*5) *adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*

6) pH dan suhu di Ukur di Laboratorium

Cibinong, 01 April 2024

Nama Pemeriksa: Nanda Rizki Winartha

Nama Verifikator: Penny Listiyanty

Kepala UPT Laboratorium Kesehatan Kelas A

Kabupaten Bogor

dr. Sri irianti H

NIP 196908072002122004

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Figure 11 Results of Laboratory Tests for Rainwater from Male's Dormitory on Day 2

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN
UPTD Laboratorium Kesehatan Daerah
Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 307/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 278/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Air Hujan Asrama Putra
   d. Tanggal dan waktu pengambilan[1] : 6 Maret 2024 Pkl. 13.13 WIB
   e. Tanggal dan jam penerimaan : 7 Maret 2024 Pkl. 10.33 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 21 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	6,13[4]	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	0,025	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	18[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli*[3]	CFU/100 mL	9[4]	0	SM APHA 23rd Ed. 9222D, 2017

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan

Bogor, 21 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas.
pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 12 Results of Laboratory Tests for Rainwater from Male's Dormitory on Day 2

DINAS KESEHATAN KABUPATEN BOGOR

UPT. LABORATORIUM KESEHATAN KELAS A

Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914

Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 2039 -Labkes
Nomor Kode Laboratorium : 0951 (KM)
Jenis contoh uji : Air minum
Nama Pemohon : ANNISA SOFIA AFIFAH
Jl. Setu Sela Kaum Pandak Karadenan
Lokasi sampling : PESANTREN TERPADU AL KAHFI ASRAMA PUTRI (AIR HUJAN)
Tanggal pengambilan contoh uji : 06 Maret 2024
Tanggal pemeriksaan contoh uji : 07 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023
Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014
Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	<0,2	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,06	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	0,01	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	0,08	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	<0,01	IKU /LM (K)-013 Spektrofotometri
6	Kromium total *	mg/l	0,05	<0,01	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	0,010	IKU /LM (K)-017 Spektrofotometri

Keterangan :
1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor
2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas
3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji
4) #)adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan
5))adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*
6) pH dan suhu di Ukur di Laboratorium

Nama Pemeriksa: Nanda Rizki Winartha
Nama Verifikator: Penny Listiyanty

Cibinong, 26 Maret 2024
Kepala UPT Laboratorium Kesehatan Kelas A
Kabupaten Bogor

dr. Sri irianti H
NIP 196908072002122004

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Figure 13 Results of Laboratory Tests for Rainwater from Female's Dormitory on Day 1

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN
UPTD Laboratorium Kesehatan Daerah
Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 305/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 276/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Air Hujan Asrama Putri
   d. Tanggal dan waktu pengambilan[1] : 6 Maret 2024 Pkl. 13.16 WIB
   e. Tanggal dan jam penerimaan : 7 Maret 2024 Pkl. 10.33 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 21 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	2,29	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	0,044	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	25[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli* [3]	CFU/100 mL	10[4]	0	SM APHA 23rd Ed. 9222D, 2017

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan

Bogor, 21 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas.
pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 14 Results of Laboratory Tests for Rainwater from Female's Dormitory on Day 1

DINAS KESEHATAN KABUPATEN BOGOR

UPT. LABORATORIUM KESEHATAN KELAS A

Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914

Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 2314 -Labkes

Nomor Kode Laboratorium : 01086 (KM)

Jenis contoh uji : Air minum

Nama Pemohon : ANNISA SOFIA AFIFAH

Jl. Setu Sela Kaum Pandak Karadenan

Lokasi sampling : PESANTREN TERPADU AL KAHFI ASRAMA PUTRI

Tanggal pengambilan contoh uji : 12 Maret 2024

Tanggal pemeriksaan contoh uji : 13 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023

Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014

Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	0,50	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,06	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	<0,03	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	0,04	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	<0,01	IKU /LM (K)-013 Spektrofotometri
6	Kromium val 6 (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :

1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor

2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas

3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji

4) #adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan

*5) *adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*

6) pH dan suhu di Ukur di Laboratorium

Cibinong, 01 April 2024

Nama Pemeriksa: Nanda Rizki Winartha

Nama Verifikator: Penny Listiyanty

Kepala UPT Laboratorium Kesehatan Kelas A

Kabupaten Bogor

UPT LABORATORIUM KESEHATAN

dr. Sri Irianti H

NIP 196908072002122004

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Figure 15 Results of Laboratory Tests for Rainwater from Female's Dormitory on Day 2

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN
UPTD Laboratorium Kesehatan Daerah
Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 325/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 296/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Sampel Air Hujan Asrama Putri (Day 2)
   d. Tanggal dan waktu pengambilan[1] : 12 Maret 2024 Pkl. 14.15 WIB
   e. Tanggal dan jam penerimaan : 13 Maret 2024 Pkl. 11.45 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 25 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	1,63	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	0,096	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	22[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli*[3]	CFU/100 mL	<1[5]	0	SM APHA 23rd Ed. 9222D, 2017

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan
5) Bakteri Total Colifrom tidak ditemukan dalam 100 mL contoh uji

Bogor, 27 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas.
pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 16 Results of Laboratory Tests for Rainwater from Female's Dormitory on Day 2

DINAS KESEHATAN KABUPATEN BOGOR
UPT. LABORATORIUM KESEHATAN KELAS A
Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 16914
Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 2043-Labkes
Nomor Kode Laboratorium : 0904 (KM)
Jenis contoh uji : Air minum
Nama Pemohon : ANNISA SOFIA AFIFAH
Jl. Setu Sela Kaum Pandak Karadenan
Lokasi sampling : PESANTREN TERPADU AL KANTI (AIR HUJAN MASJID PUTRI)
Tanggal pengambilan contoh uji : 04 Maret 2024
Tanggal pemeriksaan contoh uji : 05 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023
Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014
Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	2,50	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,08	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	0,07	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	0,16	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	<0,01	IKU /LM (K)-013 Spektrofotometri
6	Kromium val 6 (Cr^{6+}) (terlarut) *	mg/l	0,01	<0,01	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :
1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor
2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas
3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji
4) #)adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan
*5) *)adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*
6) pH dan suhu di Ukur di Laboratorium

Nama Pemeriksa: Nanda Rizki Winartha
Nama Verifikator: Penny Listiyanty

Cibinong, 23 Maret 2024
Kepala UPT Laboratorium Kesehatan Kelas A
Kabupaten Bogor

dr. Sri Irianti H
NIP. 196908072002122004

Hal 1 dari 2

Figure 17 Results of Laboratory Tests for Rainwater from Female's Mosque on Day 1

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN
UPTD Laboratorium Kesehatan Daerah
Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 286/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 257/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Air Hujan Mesjid Putri
   d. Tanggal dan waktu pengambilan[1] : 4 Maret 2024 Pkl. 16.17 WIB
   e. Tanggal dan jam penerimaan : 5 Maret 2024 Pkl. 11.25 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 18 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	0,97	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	0,030	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	60[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli*[3]	CFU/100 mL	11[4]	0	SM APHA 23rd Ed. 9222D, 2017

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan

Bogor, 20 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas.
pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 18 Results of Laboratory Tests for Rainwater from Female's Mosque on Day 1

DINAS KESEHATAN KABUPATEN BOGOR
UPT. LABORATORIUM KESEHATAN KELA
Jln. Raya KSR Dadi Kusmayadi No.27B Cibinong Bogor 1691 .
Telepon/faksimili (021) 8753269 Email labkeskabogor@gmail.com

LAPORAN HASIL PENGUJIAN

Nomor surat : 445.9/ 238-Labkes
Nomor Kode Laboratorium : 0950 (KM)
Jenis contoh uji : Air minum
Nama Pemohon : ANNISA SOFIA AFIFAH
Jl. Setu Sela Kaum Pandak Karadenan
Lokasi sampling : PESANTREN TERPADU AL KAHFI MASJID PUTRI (AIR HUJAN)
Tanggal pengambilan contoh uji : 06 Maret 2024
Tanggal pemeriksaan contoh uji : 07 Maret 2024

Berdasarkan Peraturan Menteri Kesehatan RI Nomor 2 Tahun 2023
Tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014
Tentang Kesehatan Lingkungan

NO	PARAMETER	UNIT	STANDAR BAKU MUTU (KADAR MAKSIMUM)	HASIL PEMERIKSAAN	METODE
	PARAMETER FISIK				
1	Warna *	TCU	10	<0,2	IKU /LM(K)-001 Spektrofotometri
	PARAMETER KIMIAWI				
2	Aluminium (terlarut) *	mg/l	0,2	0,06	IKU /LM (K)-006 Spektrofotometri
3	Besi (terlarut) *	mg/l	0,2	0,04	IKU /LM (K)-010 Spektrofotometri
4	Fluoride (terlarut) *	mg/l	1,5	0,15	IKU /LM (K)-007 Spektrofotometri
5	Mangan (terlarut) *	mg/l	0,1	<0,01	IKU /LM (K)-013 Spektrofotometri
6	Kromium total *	mg/l	0,01	<0,01	IKU /LM (K)-032 Spektrofotometri
7	Timbal (terlarut) *	mg/l	0,01	0,01	IKU /LM (K)-017 Spektrofotometri

Keterangan :
1) Pengambilan contoh uji diluar tanggungjawab UPT Laboratorium Kesehatan Kabupaten Bogor
2) Laporan pengujian tidak untuk digandakan dan hanya berlaku untuk contoh uji tersebut diatas
3) Pengaduan tidak akan dilayani setelah dua minggu setelah penerbitan laporan hasil uji
4) #)adalah penanda parameter yang diperiksa diluar dari standar baku mutu (kadar maksimum) yang diperbolehkan
5))adalah penanda parameter tersebut tidak terakreditasi SNI ISO/IEC 17025 : 2017*
6) pH dan suhu di Ukur di Laboratorium

Cibinong, 26 Maret 2024

Nama Pemeriksa: Nanda Rizki Winartha
Nama Verifikator: Penny Listiyanty

Kepala UPT Laboratorium Kesehatan Kelas A
Kabupaten Bogor

dr. Sri irianti H
NIP 196908072002122004

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Figure 19 Results of Laboratory Tests for Rainwater from Female's Mosque on Day 2

PEMERINTAH KOTA BOGOR
DINAS KESEHATAN

UPTD Laboratorium Kesehatan Daerah

Jl. RM. Tirto Adhi Soerjo No. 3 Tanah Sareal Kota Bogor 16161
Telp/ Faksimili : (0251) 8385082

Komite Akreditasi Nasional LP-1382-IDN

FR 5.8-1.0.1LP Rev: 1	**LAPORAN HASIL PENGUJIAN**	Hal 1 dari 1 halaman

Nomor: 308/UPTD Labkesda-KM/03/24

1. Nama pemohon : Annisa Sofia
2. Alamat pemohon : Jl. Setu Sela Karadenan Kec. Cibinong
3. Deskripsi penerimaan contoh uji
   a. Nomor laboratorium : 279/KM/03/2024
   b. Jenis contoh uji : Air Minum
   c. Identitas Contoh Uji : Air Hujan Majid Putri
   d. Tanggal dan waktu pengambilan[1] : 6 Maret 2024 Pkl. 12.55 WIB
   e. Tanggal dan jam penerimaan : 7 Maret 2024 Pkl. 10.33 WIB
   f. Kondisi saat diterima : Dikemas dalam Polietilen 2,5 Liter dan Botol Kaca 300 mL
4. Baku Mutu yang Diacu : Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan
5. Tanggal selesai pemeriksaan : 21 Maret 2024
6. Hasil pemeriksaan :

No	Parameter	Satuan	Hasil Pemeriksaan	Baku Mutu[2]	Metode
Fisika					
1.	Kekeruhan	NTU	1,30	<3	SNI 06-6989.25-2005
Kimia					
1.	Nitrit sebagai NO_2 terlarut[3]	mg/L	0,028	3	SNI 06 6989.9-2004
Mikrobiologi					
1.	Total Coliform[3]	CFU/100 mL	17[4]	0	SM APHA 23rd Ed. 9222B, 2017
2.	*Escherichia coli*[3]	CFU/100 mL	5[4]	0	SM APHA 23rd Ed. 9222D, 2017

Keterangan:
1) Pengambilan sampel di luar tanggung jawab UPTD Labkesda Kota Bogor
2) Berdasarkan Lampiran Peraturan Menteri Kesehatan RI No. 2 tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan BAB II.A.1
3) Terakreditasi SNI ISO/IEC 17025:2017 oleh Komite Akreditasi Nasional (KAN)
4) Hasil di luar Baku Mutu yang diperbolehkan

Bogor, 21 Maret 2024
Koordinator Teknis

Hendra Susanto, SSi, MSi
NIP : 19761017.200501.1.005

Hasil pengujian ini tidak untuk digandakan dan hanya berlaku untuk contoh-contoh tersebut di atas.
pengaduan tidak akan dilayani setelah dua minggu dari penerbitan laporan hasil pengujian

Figure 20 Results of Laboratory Tests for Rainwater from Female's Mosque on Day 2

APPENDIX II Rainfall Data

Table 1 Daily Rainfall Data of Bogor Regency 2014

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	6	4.7	0.3	7.2	0.5	9.7	0	0	0	0	26	0
2	2.2	32.6	11.2	0.3	0.7	0	0	0	0.8	0	0.8	0
3	21.6	34.2	29.4	3	3.8	0	1.2	2.8	0	0	26	0.4
4	0	78.7	-	3	0	0	0	7.4	0	0	0	-
5	5	26.3	1.3	4	0	6.1	0	59	0	0	41	0
6	1.6	11.6	16.5	30.3	0	0.9	34.5	0	0	-	3.6	2.7
7	0	25.5	14.6	99.2	0	0	1.5	0	0	0	6.9	3.3
8	1.2	18.1	6	0	0	0	0.6	0	0	2.5	0.3	3
9	6	42.3	3.2	0	21.4	0	17.5	0	0	5.9	20.8	2.5
10	0	33.2	16	26.8	0.7	0	2.6	0	0	0	11.1	0
11	23.9	2.5	-	1.8	0	0.4	7.2	10.4	0	0	50	1.4
12	64.6	0.1		7.8	19.8	0	6.5	24.2	0	0	25.8	-
13	132.5	0	6.1	0	0.3	0.2	54.7	35.3	0	0	33.4	3.7
14	13.4	0	52.5	23	1	84.6	23.6	0.3	0	14.3	49.6	0
15	37.3	0	0	37.1	6.9	11.6	0	9	0	0	0.2	-
16	13.9	0.5		1.8	52.4	10.3	0	0.2	0	18.8	0	-
17	0	21.6	0	80	18.7	30.2	0	0	0	0.4	49.3	3.3
18	140.6	1.2	21.5	2.4	0.5	2.7	0	0	0	0	35.9	-
19	74.8	0.1	18.9	18.5	0.9	9.6	0	0	0	0	2	7.8
20	16.5	12.8	4.6	0	14	0	70.5	0	0	0	86.5	75.2
21	78.9	0.5	1.8	0.1	19.6	0.5	54.5	9.8	32.4	0	0	15.5
22	78.3	23.4	1.6	2.2	1.7	10.2	0.6	0.3	0	0	1	91.5
23	48.8	95.7	0	-	43.7	4.7	0.8	0	0	5.3	1.3	52
24	54.6	35.9	0.1	1.7	8	0	0.4	6	0	10.5	5.7	26.7
25	25	71.1	8.5	0	0	0	0	5.4	0	0.3	17.9	33.5
26	1.6	33.4	3.7	34.4	1.8	16.4	0.1	23.8	0	9.5	27.5	6.9
27	17.3	7.1	-	3.6	0.7	1	66.4	2.2	0	21.5	6.8	109.9
28	0	10.7	46.9	4.8	1.9	0	0.8	0	0	0	-	0
29	52.3	0	0	1.9	0	0	0	26.5	0	0.2	3.9	4.9
30	192.8	0	2	8.9	0	0	0.1	26.9	0.4	5	15	-
31	23.3	0	0	0	0.9	0	0	0.3	0	0	0	1.5

(Source: BMKG Online Data Centre)

Table 2 Daily Rainfall Data of Bogor Regency 2015

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	6.2		52	32	0	0	0	0	0	0	0	3.2
2	4	36.8	10.6	2.2	12	7	0	0	0	0	11.7	9.6
3	0.8	0	31.1	11.5	1.7	0.3	0	0	0	1.3	1.7	6.3
4	13.2	13.7	2.2	2.6	44	0	0	0	0	0	0	0
5	25.2	36	0	13.7	2.9		0	0	0	0	-	3.1
6	0	2.8	2.4	0	42	0	0	0	0	0.9	3.9	13
7	2.8	25.3	0	1.7	25.4	-	0	0	0	0	0	15.9
8	7.8	8.2	0.1	-	0.1	5.7	0	0	0	11	13.7	44.1
9	-	37	15.9	1.3	0.9	-	0	0	0	22.5	50	16.5
10	0.1	38.6	6.2	0.3	-	1.8	0	0	0	1	31.2	39
11		4.9	0.8	0	0	0	0	0	0	-	17.1	9.1
12	0.4	1.7	18.8	14.4	0	0	0	0	0	0	12	33.4
13	5.5		2.4		0	0	0	0	0	-		24.5
14	24.5	18	4.8	-	10.9	0	0	0	0	12.5	63.7	7.3
15	11.5	0	0	20.9	2	0	0	0	0	-	-	11.8

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
16	3	7	0	11.9	4.2	0	0	0	0	0	31.9	
17	9.3	3.6	0	1.1	1.7	0	0	0	0	0	86.6	42.8
18		9.1	0	0	0.1	0	0	0	0	0	3.2	3.2
19	1.8	71.8	10.9	0	0	0	0	0	0	0	5.6	16
20	6.8	13	67.8	1	0	0	0	0	0	0	5	2.8
21		0	5	11	0	0	0	0	0	0	6	39.9
22	41.5	0	0		0	0	0	0	8.4	0	0.3	13.2
23	32.8	0	37	45.1	0	0	0	0	0	0	30.8	0
24	0.5	2.7	0	0.3	0	0	0	0	-	0	-	0
25	22.7	0	5.9	0	0	0	0	0	0	0	44.6	0
26	10.4	0.7	17.6	0	0	0	0	0	8.8	0	26.5	0
27	4.8	0	6.5	18.1	0.1	0	0	0	0	0	0	0
28	5	14.5	0.8	7.2	0	0	0	0	0	0	0	20.5
29	36.2	0	1.2		0	0	0	0	1.6	0	10.1	0
30	0.4	0	0	-	0	0	0	0	0	-	2.1	31.4
31	7	0	35.7		0	0	0	0	0	0.9		2.4

(Source: BMKG Online Data Centre)

Table 3 Daily Rainfall Data of Bogor Regency 2016

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1.2	13.1	54.4	1.1	28.8	-	1.1	0	7.6	20.7	2.5	3.6
2		60.7	21.9	27.3	0	0	1.1	0.1	6.5	0.5	3.1	9
3	43.9	74.4	22	51.7	19.5	0.8	-	0	7.8	6.1	2.4	12.5
4	8.7		14	6.4	0.2	0.1	55.8		45	0.8	3.4	2.1
5	-	10.2	32.2	3.5			1	0	18.4	32.2	0.4	13.1
6	33.2	7.8	32.1	46.1	0	0	1.5	0	0	5.8	0.8	2.2
7	9	0	6.1	18.4		0	0	0	2.5	2.7	78.4	0.1
8		49.8	40.4	9.2	2.2	38	0.4	0.2	22	32.7	3.5	0.9
9		40.6	5.5	4.4	4.7	13	14.6	6.8	15.5		41.3	6.3
10	4.8	20.5	29	50.4	12.6	5		0.8		18.9	0.8	3.8
11	0	64.9	22.2				0	0.2	16.4	69	16.7	3.1
12	13.8	6.1	32.6	14.2	-	0.2	10.6	-	-	1	13.1	36
13	23.3	5.7	9.5		42.2	0	-	11	0.4	4.4	2.3	0.8
14	45.5	26.3	19.4	2	1.3	0	0.6	14	-	-	15.3	2.6
15	0	0.6	13.4	1.7	0	0	0	7	39.6	-	2.4	17.1
16		0.1	0	-	10	0.2	0.7	0	-		8.4	2.3
17	0	4	2.4	1.4	0.7	0	22.3	0.5	0.4	0	14.9	-
18	0	4	43.1	17	23.7	80.5	12	2.7	0.1	0.6	16.9	
19	20.9	6.4	0	9.5	0	8.8	25.4	1	48.1	16.2	15.4	2.4
20	21.6	2.5	0	18.2	2.1	-	26	0	20.7	0.4	1.4	11.1
21	6.1	26.9	3.9	17.8	17.7	-	0	3	0.1	0.4	11.9	0
22	2.3	58.6	1.2	54.5	34.1	0.2	16.8	-	7.2	18.4	9.4	0.2
23	0.9	42.5	36.2	1	14.7	0	55.3	0	11	14.1	12.5	0.4
24	3.4	0.2	6.9	1.5	3.5	0	2.5		0.4	12.3	11	-
25	16.8	13.6	1.3		4	0	2.8	0.8	22.8	6.2	1	
26	0.8	9.9	14.4	23.5	9	0	0	3.8	22.7	14.9		2.5
27		16.3	22.3	3.1	0	10.5	0	-	-	2.7	17.5	
28	0	7		9.4	0.2	-	0	9.1	26.4	16.6	1.7	0.8
29	1	9	21.5	47.7		0		-	14.8	41.5	1.2	0.1
30	5.4		45.3	20.2	-	44.4	1.1	10	9.5	9.6	-	0.2
31	9.9		-		0		1	11.6		38		9.3

(Source: BMKG Online Data Centre)

Table 4 Daily Rainfall Data of Bogor Regency 2017

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	14.7	51.5	0.9	1.1	1	7.2	5.2	-	0	-	11.3	41
2	2.1	10.4	14	6.2	48.5	9.3	0	0	0	7.9	0	10.7
3	2.3	1.4	2.1	34.6	34.2	0	0	0	0	22.5	0	0
4	14	24.6	4.2	0.7	31.6	0.8	8.6	0	0	13.4	-	0
5	4.2	28.2	21.3	2	10.6	4	3.3	0	0	26.9	7.8	0
6	30.6	45.4	9	0.8	18.5	30.7	0.4	0	0	0.3	18.9	0
7	3.9	3.3	21.9	0	16.5	0	0	0	0.6	0	35.7	1.5
8	0	20.4	66.2	2.7	1.8	0	0	0	-	40.3	7.5	3.5
9	-	50.4	21	0.1	27.9	0	-	4.6	0	2.6	17.5	5.1
10	4	31.3	0.2	6.8	-	0.4	0.9	24	0.2	32	15.6	14.6
11	5	39	11.4	36.7	13.3	0.2	-	1.9	2.1	6.1	34.5	0.2
12	20.9	63.7	0.7	11.4	0	2.9	0	2	0	26.3	7.9	48.2
13	2	34.8	1	12.5	0.3	-	0	0	0	3	3.3	36.4
14	3	4.8	0	39.2	0.3	0.2	0	0	0	0.9	2.5	5.6
15	16.5	36.3	0.3	0	0	8.4	0	-	0	0	14.6	3.4
16	1.7	44	8.7	34.5	0	0	0	0	0	0.4	-	6.2
17	6.5	27.5	0.1	24.9	-	0	0	0	0	3.8	57.7	2.7
18	5.4	2	22.2	0	0	0	0	0	0	11.9	90	20.6
19	-	0	16.7	31	0	1.2	-	0	0	33.3	1.6	23.4
20	-	4.5	-	51.6	0	0	1.4	0	0	18.7	4	32.2
21	1.8	32.2	7.3	0.2	0	0	0	0	0	15.5	0	11.4
22	7.1	7	10.4	5.2	-	0	0.1	0	0	0.5	11.6	36.8
23	58.4	28.8	11.3	35.3	0	5.4	1.1	0	0	0	0.1	-
24	1.1	10	0.3	5.5	0.3	0.3	28.2	0	0	-	0	-
25	12.7	38.2	18.2	0.4	15.8	-	0	0	5.2	0.3	0	0
26	-	20	0	19.4	0	2	0	0	3.9	60	-	0
27	0	11.4	8	13.1	0	12.4	0	0	1.7	1.3	21.5	0
28	7.7	17.4	4.3	22.5	0	0	37.9	0	8.6	0.6	44.5	0.2
29	9.5		0	1	4.8	10.6	1	0	0	22.9	2.7	0
30	19.3		0.7	1.4	0.5	34.8	1	16.8	11.4	0	10	10
31	6.6		1.3		0		-	0		16		7

(Source: BMKG Online Data Centre)

Table 5 Daily Rainfall Data of Bogor Regency 2018

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-		6	0.1	0	0	0.2	0	4.3	0	2	2.8
2	0.6	1.3	18.1	13.3	0	0	0	0	0	0	15.6	0.7
3	0.5	24.7	4	46	0	0	0	0	14.9	0	5	3
4	20	26.7	63.1	18.4	1.2	0	0	0	0	2.1	8.9	16
5	0.4	152	-	5.4	0.2	0	0	0	0	0.1	3.9	24.5
6	21.2	164.1	0.2	18.6	0.5	0	0	0	0	0	2.4	11.5
7	-	46.5	6	2.5	0	0	0	0	0.1	0	10.9	10.8
8	5.3		0.5	40.6	0	0.1	0	0	50	0	12.7	4.3
9	22.2		4.7	3.7	-	0	0	0	0.2	0	9.5	1.4
10	7.2		48.9	48	0	0	0	0	0	0	2.4	-
11	0.1	-	11.3	0	0	0	0	0	0	0.4	26	-
12	6.1	15.1	9.1	0	0	0.8	0	0	0	0	35.6	-
13	1	18.7	78.8	0	0	3.8	0	11.5	0.1	-	6.5	8.3
14	15.1	3.4	0.1	2.7	0	-	0	0	0	0	10.2	20.6
15	9.5	33.6	-	7.5	0	0	0	0	0	-	0.3	23
16	17.1	18.4	0	15.9	0.2	0	0	0	0	0.9	0.9	27.7
17	8.4	4.6	0.4	0	9.8	0	1	0	0	0.5	0	3.5

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
18	1.6	0.2	19.5	17.1	2	0	-	0	0	-	3.1	0
19	1.5	0.8	6	1.4	16.8	0	0	0	0	25	0	-
20	2.3	31.5	9.5	1.7	18.5	0	0	0	0.4	0.8	13	3.5
21	1.6	8.6	21.4	2.3	32.9	0.5	0	0	20.8	19.6	5.6	0
22	21.2	7.5	28.4	2.9	-	0	3	0	3.9	0	52.6	-
23	39.4	2.4	47.4	3.4	6.5	12.9	4.8	0.1	0.5	50.1	0	-
24	14	5.6	6.2	11.9	15.3	58	-	0.2	29.6	6.1	6.2	0
25	13.7	8	23.1	1.4	0	50.2	0	0	0	2.9	41.2	0
26	11.3	21.5	15.9	9.3	-	17.8	0	0	0	7.4	9.8	31
27	30.6	33	1.3	13.2	4	8.3	0	0	0.9	2.5	38.3	0.9
28	3.8	43.3	0.8	3.5	-	0	0	0	36	3.7	28.3	-
29	17.4		0	0	0.1	0	0	0	0	5.6	-	0
30	4.5		0	-	0	0	0	0	0	-	31.2	2.1
31	35.5		1.3		0		0	8.7		2.7		0.1

(Source: BMKG Online Data Centre)

Table 6 Daily Rainfall Data of Bogor Regency 2019

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	23.5	10	8.5	1.6	3.1	0	0	0	0	0	0	9.3
2	23.3	21.5	15.2	5	1.5	-	0	0	0	0	0	36.5
3	8.8	-	14.1	-	1.1	9.3	0	0	0	-	0.1	0
4	0	1.3	2.1	1	-	5.3	0	0	0	0	7.3	0.5
5	2.2	0	-	15.2	0	0	0.3	0	0.6	0	-	2.4
6	-	0.1	15.8	1.7	39.6	0	22.3	0	0.1	0	-	1.7
7	0	35.3	20	0	0	-	0	0	1	0	0	4.5
8	30.8	-	0	5.5	26.2	38.8	2	0	0	0	0	-
9	9.3	-	10.6	0.3	12.4	1.5	9.3	0	0	-	-	2.5
10	0.7	23.5	2	0.5	10.4	0.5	1.5	-	0	-	0	3
11	9.2	8	-	0	0	0	0	0	0	44.4	0	0
12	31.2	32.9	5.4	0.9	0.9	0	0	0	0	0	3.8	16
13	20.2	-	14.4	2.6	16.4	0	0	0	0	19.1	-	0
14	29.1	0	1.1	35	-	0	0	0	0	0.4	9.4	14
15	2.3	65.9	0	29	0	4.8	0	0	0	0	0	39.5
16	1.4	87.4	8.4	27	53.4	0	0	0	0	0.5	28	4.8
17	0.1	7.5	0	25.5	-	1.7	0	0.7	0	0	0	24.4
18	4.6	11.1	7.5	6	0	0	0	0	0	1.1	0	20.7
19	15.7	-	9.6	4.1	0	0	0	0	0.7	0	0	19.6
20	5.4	30.8	7.1	26.9	0.1	0	-	0	0	0	10	2.5
21	80.3	37	3.9	1.1	0	0	0	0	-	0	46.8	10.5
22	6.3	4.4	1.6	0	0	0	-	0	0	0	0.6	0.1
23	18.2	0.7	3.1	0.3	0.5	0	0	0.6	0	0	14.2	10.2
24	3	17.6	1.4	120.5	0	0	0	0	0	0	9.9	0
25	46.9	3.4	0.2	55.9	0	0	0	0	0	0	0.1	5.4
26	11.4	29.5	5.7	68.5	0	0	0	0	0	0	0	17
27	0.8	0	25.4	11	-	0	0	0	3.4	5.6	-	3
28	1	0	15.5	14.5	1.3	0	0	11.5	0	0	1.1	13.7
29	11.4		3.7	3.1	0	0	0	6	0	0	0	1.6
30	6.7		-	0.3	-	0	0	0	0	0.1	12.5	0
31	4.5		8.5		0.5		0	-		0		57.5

(Source: BMKG Online Data Centre)

Table 7 Daily Rainfall Data of Bogor Regency 2020

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	60	13.8	33.8	32	22.5	4.1	0	0	0	-	12.7	39.6
2	73.7	20.6	32.2	2.5	16.3	12.4	0	0	0	0	10.9	4.4
3	6.8	3.8	7.6	0.2	1.5	8.2		0.2	-	-	0	2.7
4	0.8	2.3	10.4		0	1	32.3	0	1.5	17.6	0	6.9
5	5.8	4.7	11.5	12.3	0		-	0	0	7.5	0	4.4
6	5.8	42.8	9.7	26.2	13.5	0.1		0.7	0	0	2.5	56.9
7	20.4	4.2	13.7	25.6	4.5	0.2	2.4	-	0	0	0	57.8
8	6.5	118.7	0	9.2		11.7	0	0.6	-	1.6	1	2.2
9	25.3	8	3.8		2.9		23.6	0	0	3.5	11.5	1.6
10	44	0.7	0	1.8		1.9	0	0.4	-	0.1	0	6.8
11	1.8	0	3.9	5.4	13.6	0.1	0	-	0	25.7	6.3	14.3
12	0.1	0	15.3	3.2	6.5	3.9	0	2	-		26.4	15.6
13	0	2	35.4	18	1	0	1.2	0.2	0	0	4.2	3.2
14	2.3	8.6	0	15.5	0.1	0.5	0	30	0.6	1.2	0	2.2
15	11	2.2	0.9	-	0.5	0		2.8	0	0	13.5	1.5
16	0.7	8.2	43.4	2.4	0	0	-	-	0	0.1	0	3.3
17	0.2	19.4	30.7		-	0	-	0	0	28.2	2.4	2.5
18	1	1.9	2	26.2	15.2	0		0	0	5.8	10	2.8
19	0	30.3	1.5	36.9	43.5	5.8	0	1.1	0	10.8	0	0.1
20	9.6	76.4	20.3	18	13.6	0	1.2	0	0	35	1.1	-
21	8.3	32.2	19.3	0.5	62.4	0	0.5	0	0	6	0	2.2
22	0	19.1	9.9	4.5	0	0	1.9	0	0	15.5	14.2	29.9
23	1.1	16.9	11.3	-	19	32.5	-	0	0	2.2	3.1	19.4
24	43.3	41.6	15.5		-	5.8		0	0	2.2	22	-
25	2.8	37.2	55.5	4.3	4.5		0	0	0	54.7	5.3	7.3
26	23.1	7.6	14.5		7.1	0	0	0	0	3.8	6.1	4.4
27	5.9	3.5	42.1	6.6	-	-	0	0	0	20.6	0	1.8
28	23.2	2.4	10.6	13.5	30.7	0.1	0	0	66	14.1	1	-
29	0	8	4.8	13.4	0	0	0	0	0.3	7	10.8	1.3
30	37.8	0	11.2	50	42	0	0	0	0	0	0.7	17
31	0	0	41		62.7	0	0	0		13.4		7.8

(Source: BMKG Online Data Centre)

Table 8 Daily Rainfall Data of Bogor Regency 2021

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	1.3	3.1	-	48.5	8.8	1.6	0.6	27	-	53.1	40	26.8
2	14	3.3	-	0.2	7.3	0.3	16	48.5	0	0	6.7	
3	21.6	17.3	2.1	21	0	29.2	0	0.3	-	-	21.7	0
4	2	13	36.5	5.1	0	0	0	0.3	0	8.7	1.5	0.1
5	8	50.7	1.2	4.1	0	-	0	20.8	0	0	8.4	16.5
6	3.6	57	2.5	5.7	13.5	0	0	6	0	0	18.7	8.3
7	23.8	104.4	3.8	0	1.8	4	0	0	24	0	8.6	53.3
8	2.4	124	2.2	13	-	0	0	0	1.5	0	33.8	37.7
9	3.2	14.7	0.6	1.9	1	0.4	0	6.8	3.1	0.4		3.7
10	40.9	4.8	0	0.4	0.2	0.1	2.6	13.6	0	0	26.7	14.6
11	2	10.3	16.8	-	0	-	-	0	0	0	4.8	38
12	0	0.8	0	79.1	0	25.8	0	0	-	3.2	0.2	30
13	21.7	5.7	0.5	7.8	-	25.8	0	0	24.8	17.7	5.4	0.1
14	0.8	0.3	-	18.5	0	-	0	0	8.7	4	6	0.1
15	6.8	7	-	23	0	0	0	0	13.1	0	4.2	1.7
16	0	7	19.1	25.4	0.8	4.3	0	0	24.7	1.5	1	3.9

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
17	0	10.1	0.5	12.2	14.6	6	0	0	0	0.2	0.3	37.9
18	-	0.9	10.6	18.4	25.7	6	0	-	0	13.3	0	53.3
19	70	26	30.7	21.2	0	16.5	0	25.2	0.4	12.6	3.5	0.7
20	29.9	59	0.6	3.3	0	0.5	4.2	11.9	10.3	24.5	18.9	4.8
21	12	40.7	0	3.6	-	36.3	3.8	0	0	3.5	0.2	6.3
22	11.4	0	-	2.4	-	28.1	1	4.1	50.5	-	0.5	36.4
23	0.3	31.7	1	0.2	5.9	55.8	0	0	0	16.8		18.3
24	0	5.2	-	0	-	0.2	23.5	1	1	0	0.9	21
25	20.1	22.5	2.9	0	11.3	-	14.6	-	0.3	0		1.8
26	8.7	66.2	21.3	0	0	1.4	0	0	5	6	0.5	1.8
27	2	1.4	0	-	0	6	0	0	18	7.7	2.3	0
28	1.8	0	30.7	0.5	0	4.9	0	0.2	2	35.2	55.8	5
29	45		1	42.7	3	0	0	0	0.2	63.4	3.7	8.5
30	5.2		0.1	-	17.8	4.4		-	0	12.4	69.5	14.5
31	25.5		2.7		3.6		0	0		26.8		0.9

(Source: BMKG Online Data Centre)

Table 9 Daily Rainfall Data of Bogor Regency 2022

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.1	62	10.2	19.5	6.8	72.4	0			0.2	0.1	9.7
2		25	6.4	-	6.4	-	0		0.2	4.6	0	0.8
3	0.1	11.7	6.9	-	22.8	21.7	2.8		2	7.2	24.3	14
4		0.1	2.3	14.8		0.1	0.2		7.5	49.2	4.3	17.7
5	0	3.9	-	0.6	4.7	6.7	0	2.6	6.4	6.1	15.6	9.8
6	1	17.3	13.3	18.1	0.2	9.3	5.9	-	7.6	-	15.7	4.4
7	2	30.2	3.9	6	0	86.8	16.6	13.4		27.2	0.1	34.2
8	1.2	8.2	1.1	1.5	3	0	7.2	1.8	34.7	33.4	57	19.5
9		23.6	10	1.8	-	18.7	0		18.1	8	7.5	1.3
10	1.6	5.1	19.4	24	5.6	15.5	0	-	11.6	76	0.2	20.8
11	1.6	3.5	1	2.7	0.6	24	0	0.6	18.5	0	1	2.5
12	6	0.4	12	27.4	2.1	2.2	0	3.5	15.2	27.5	2.2	12.5
13	14.2	1	46.6	0.7	0	23.7	23.3	51.7	29.3	15.5	16.5	3.4
14	12.1	0.3	43	18.5	0	1.4	6.7	6.4	2.8	15.5	18.2	7
15	13.7		5.3	0.1	2.6	0	1.2	52.9	0	14.6	17.2	0.7
16	18.5	0.2	0.2	64	19	7.6	46.6	2	0	18.5	0	16.5
17	0.7	33.6			1	0	4.9	26.3	32.9	0	16	34.7
18	9	20	0.2	0.5	12	3.1	0	-		-	9.6	20.4
19	2.8	4.8	25.1	89.1	35	1.2	0			32.8	19.4	0.2
20	12.8	2.3	0	63.5	4.7	0.5		0		8.4	1	0
21	7	9.8	-	9.2	36.2	6.2		0.8	1.9	6.8	0	15
22	4.1	-	0.6	2.7	1.5			43.5	14.4	29.6	0	3
23	-	0.8	5.6	4.3		7	0.1	0.1	24.1	28.6	-	8.1
24		16.9	3.4	14.3	-	0.7	7.5	-	11.4	1.1	11.3	0.1
25	0	2.2	3.4	0	0	3.5	20.4	0		1.2	8.1	19.3
26	-	3	12.1	21.1	14.4	3.9				76.6	2.2	9.6
27	0.4	9.5	0.5	0	-	15.5	0	0.5	3.4	0.7	-	37
28		8.6	6.8	51.2	11	16.6	0	18	0.2	0	1.5	10.9
29				-	15.2	0	0	3.1	0.5	0	26.4	24.4
30				0	0.4	0	0	19.4	-		7.8	66.7
31	1.3		0		13.1		0	0				4.5

(Source: BMKG Online Data Centre)

Table 10 Daily Rainfall Data of Bogor Regency 2023

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	31.4	10.4	3.2	23.8	61.9	0	5.4	0	0	3.7	7.8	28.9
2	1.6	1.1	25.7	4.5	5.4	0		0	0	0.1	0.2	5
3	4.1	4.9	22.7	-	0.1	0		0.6	0	0	2.3	6
4	10.8	-	7.7	0	86.4		0	2.4	0	0.1	24.5	32.6
5	-	-	16.3		10.4	33.5			0		46.8	6.7
6	7.8	-	10.3	1	18.5	0.1	4.5	0	0	4.7	3.9	7.6
7	0	1.3	0	0	1.6	9		0	0	0	0	3
8	0.7	0.6	0	0.1	3.3	0	16.4	0	0	0	0	0
9	5.5	-	-	2.8	25.6	0.2	13.2		0	0	-	4.6
10	1.5	6.3	45.5	25.5	-	0.1		0	0	2.2	-	0.3
11	0	10.4	10.8	1	0	0		-	0.1	-	0.3	0
12	3.9	84.6	0.4		0	0		0	0	0.5	0.4	0
13		30.8	16.4	2	0	0	0	0	0	0.5	0	0
14	-	19.5	0	0	31.9	8.5	0	0	0	0	0.1	0
15		13.5	3.1	5.3	0	0.1	1.4		0	2.4	40.9	0
16	0	25.8	-	1.2	0	0	0	0	0	0	0.4	0
17	2	5.6	0		0	5.5	0		0.7	0	41.5	0
18	3.2	13	15.4	0.4	0	-	0	0	0.5	0	2	0
19	0	23	8.5	6.4	0	5.3	0	0	1.6	0	1.7	0.2
20		9	1.6	11.7	0	6.9	0	0	0.1	0	0	0
21	0.1	-	37.5	11.3	0	0	0		-	36	0.4	0
22	0.1	7.3	2	9.7	10.1	0	0	0	0.5	7.6	8.4	0
23	1.2	31.1	16.8	0.1	0.6	5.3	0	0	0		44	0
24	3	59	1.5	16.9	0	2	0	0	0	0	0	0
25	6.8	51	2.5	11.4	0	-	-	0	0	14.8	24.7	18.5
26	17.3	36.2	3.9	7	21.5	0	4.7	1.2	-	6	0.7	2.2
27	1	76.5	23.7	0.4	0	0	4.5	0	0	0	-	9.2
28	14	26.5	2	23.5	2.3	0		2.4	0	0	0	29.7
29	39.1		0	14.2	2.5			-	0	0	26.2	8.3
30	3.4		16.8	0.1	12	-	0	0	0	0	65.6	3
31	-		0		0		0	0		-		13.3

(Source: BMKG Online Data Centre)

APPENDIX III Rainwater Storage Volume each Building

Table 11 Rainwater Storage Volume Building B

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
1	6	371	2	2	7.92	8	-6
2	2.2	371	1	3	7.92	16	-13
3	21.6	371	7	10	7.92	24	-14
4	0	371	0	10	7.92	32	-22
5	5	371	2	12	7.92	40	-28
6	1.6	371	1	13	7.92	48	-35
7	0	371	0	13	7.92	55	-42
8	1.2	371	1	14	7.92	63	-49
9	6	371	2	16	7.92	71	-55
10	0	371	0	16	7.92	79	-63
11	23.9	371	8	24	7.92	87	-63
12	64.6	371	20	44	7.92	95	-51

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
13	132.5	371	40	84	7.92	103	-19
14	13.4	371	4	88	7.92	111	-23
15	37.3	371	12	100	7.92	119	-19
16	13.9	371	5	105	7.92	127	-22
17	0	371	0	105	7.92	135	-30
18	140.6	371	42	147	7.92	143	4
19	74.8	371	23	170	7.92	150	20
20	16.5	371	5	175	7.92	158	17
21	78.9	371	24	199	7.92	166	33
22	78.3	371	24	223	7.92	174	49
23	48.8	371	15	238	7.92	182	56
24	54.6	371	17	255	7.92	190	65
25	25	371	8	263	7.92	198	65
26	1.6	371	1	264	7.92	206	58
27	17.3	371	6	270	7.92	214	56
28	0	371	0	270	7.92	222	48
29	52.3	371	16	286	7.92	230	56
30	192.8	371	58	344	7.92	238	106
31	23.3	371	7	351	7.92	246	105
Max							106
Min							63
Volume of Reservoir (m³/month)							170
Volume of Reservoir (m³/day)							6

Table 12 Rainwater Storage Volume Building C

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	448	3	3	8.4	8	-5
2	2.2	448	1	4	8.4	17	-13
3	21.6	448	8	12	8.4	25	-13
4	0	448	0	12	8.4	34	-22
5	5	448	2	14	8.4	42	-28
6	1.6	448	1	15	8.4	50	-35
7	0	448	0	15	8.4	59	-44
8	1.2	448	1	16	8.4	67	-51
9	6	448	3	19	8.4	76	-57
10	0	448	0	19	8.4	84	-65
11	23.9	448	9	28	8.4	92	-64
12	64.6	448	24	52	8.4	101	-49
13	132.5	448	48	100	8.4	109	-9
14	13.4	448	5	105	8.4	118	-13
15	37.3	448	14	119	8.4	126	-7
16	13.9	448	5	124	8.4	134	-10
17	0	448	0	124	8.4	143	-19
18	140.6	448	51	175	8.4	151	24

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
19	74.8	448	27	202	8.4	160	42
20	16.5	448	6	208	8.4	168	40
21	78.9	448	29	237	8.4	176	61
22	78.3	448	29	266	8.4	185	81
23	48.8	448	18	284	8.4	193	91
24	54.6	448	20	304	8.4	202	102
25	25	448	9	313	8.4	210	103
26	1.6	448	1	314	8.4	218	96
27	17.3	448	7	321	8.4	227	94
28	0	448	0	321	8.4	235	86
29	52.3	448	19	340	8.4	244	96
30	192.8	448	70	410	8.4	252	158
31	23.3	448	9	419	8.4	260	159
Max							159
Min							65
Volume of Reservoir (m³/month)							224
Volume of Reservoir (m³/day)							8

Table 13 Rainwater Storage Volume Building D

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	171	1	1	5.28	5	-4
2	2.2	171	1	2	5.28	11	-9
3	21.6	171	3	5	5.28	16	-11
4	0	171	0	5	5.28	21	-16
5	5	171	1	6	5.28	26	-20
6	1.6	171	1	7	5.28	32	-25
7	0	171	0	7	5.28	37	-30
8	1.2	171	1	8	5.28	42	-34
9	6	171	1	9	5.28	48	-39
10	0	171	0	9	5.28	53	-44
11	23.9	171	4	13	5.28	58	-45
12	64.6	171	9	22	5.28	63	-41
13	132.5	171	19	41	5.28	69	-28
14	13.4	171	2	43	5.28	74	-31
15	37.3	171	6	49	5.28	79	-30
16	13.9	171	2	51	5.28	84	-33
17	0	171	0	51	5.28	90	-39
18	140.6	171	20	71	5.28	95	-24
19	74.8	171	11	82	5.28	100	-18
20	16.5	171	3	85	5.28	106	-21
21	78.9	171	11	96	5.28	111	-15
22	78.3	171	11	107	5.28	116	-9
23	48.8	171	7	114	5.28	121	-7
24	54.6	171	8	122	5.28	127	-5

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
25	25	171	4	126	5.28	132	-6
26	1.6	171	1	127	5.28	137	-10
27	17.3	171	3	130	5.28	143	-13
28	0	171	0	130	5.28	148	-18
29	52.3	171	8	138	5.28	153	-15
30	192.8	171	27	165	5.28	158	7
31	23.3	171	4	169	5.28	164	5
Max							7
Min							45
Volume of Reservoir (m^3/month)							52
Volume of Reservoir (m^3/day)							2

Table 14 Rainwater Storage Volume Building E

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
1	6	687	4	4	16.56	17	-13
2	2.2	687	2	6	16.56	33	-27
3	21.6	687	12	18	16.56	50	-32
4	0	687	0	18	16.56	66	-48
5	5	687	3	21	16.56	83	-62
6	1.6	687	1	22	16.56	99	-77
7	0	687	0	22	16.56	116	-94
8	1.2	687	1	23	16.56	132	-109
9	6	687	4	27	16.56	149	-122
10	0	687	0	27	16.56	166	-139
11	23.9	687	14	41	16.56	182	-141
12	64.6	687	36	77	16.56	199	-122
13	132.5	687	73	150	16.56	215	-65
14	13.4	687	8	158	16.56	232	-74
15	37.3	687	21	179	16.56	248	-69
16	13.9	687	8	187	16.56	265	-78
17	0	687	0	187	16.56	282	-95
18	140.6	687	78	265	16.56	298	-33
19	74.8	687	42	307	16.56	315	-8
20	16.5	687	10	317	16.56	331	-14
21	78.9	687	44	361	16.56	348	13
22	78.3	687	44	405	16.56	364	41
23	48.8	687	27	432	16.56	381	51
24	54.6	687	30	462	16.56	397	65
25	25	687	14	476	16.56	414	62
26	1.6	687	1	477	16.56	431	46
27	17.3	687	10	487	16.56	447	40
28	0	687	0	487	16.56	464	23
29	52.3	687	29	516	16.56	480	36
30	192.8	687	106	622	16.56	497	125
31	23.3	687	13	635	16.56	513	122

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
Max							125
Min							141
Volume of Reservoir (m³/month)							266
Volume of Reservoir (m³/day)							9

Table 15 Rainwater Storage Volume Building G

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	681	4	4	11.04	11	-7
2	2.2	681	2	6	11.04	22	-16
3	21.6	681	12	18	11.04	33	-15
4	0	681	0	18	11.04	44	-26
5	5	681	3	21	11.04	55	-34
6	1.6	681	1	22	11.04	66	-44
7	0	681	0	22	11.04	77	-55
8	1.2	681	1	23	11.04	88	-65
9	6	681	4	27	11.04	99	-72
10	0	681	0	27	11.04	110	-83
11	23.9	681	14	41	11.04	121	-80
12	64.6	681	36	77	11.04	132	-55
13	132.5	681	73	150	11.04	144	6
14	13.4	681	8	158	11.04	155	3
15	37.3	681	21	179	11.04	166	13
16	13.9	681	8	187	11.04	177	10
17	0	681	0	187	11.04	188	-1
18	140.6	681	77	264	11.04	199	65
19	74.8	681	41	305	11.04	210	95
20	16.5	681	9	314	11.04	221	93
21	78.9	681	43	357	11.04	232	125
22	78.3	681	43	400	11.04	243	157
23	48.8	681	27	427	11.04	254	173
24	54.6	681	30	457	11.04	265	192
25	25	681	14	471	11.04	276	195
26	1.6	681	1	472	11.04	287	185
27	17.3	681	10	482	11.04	298	184
28	0	681	0	482	11.04	309	173
29	52.3	681	29	511	11.04	320	191
30	192.8	681	105	616	11.04	331	285
31	23.3	681	13	629	11.04	342	287
Max							287
Min							83
Volume of Reservoir (m³/month)							370
Volume of Reservoir (m³/day)							13

Table 16 Rainwater Storage Volume Building H

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
1	6	340	2	2	9.84	10	-8
2	2.2	340	1	3	9.84	20	-17
3	21.6	340	6	9	9.84	30	-21
4	0	340	0	9	9.84	39	-30
5	5	340	2	11	9.84	49	-38
6	1.6	340	1	12	9.84	59	-47
7	0	340	0	12	9.84	69	-57
8	1.2	340	1	13	9.84	79	-66
9	6	340	2	15	9.84	89	-74
10	0	340	0	15	9.84	98	-83
11	23.9	340	7	22	9.84	108	-86
12	64.6	340	18	40	9.84	118	-78
13	132.5	340	37	77	9.84	128	-51
14	13.4	340	4	81	9.84	138	-57
15	37.3	340	11	92	9.84	148	-56
16	13.9	340	4	96	9.84	157	-61
17	0	340	0	96	9.84	167	-71
18	140.6	340	39	135	9.84	177	-42
19	74.8	340	21	156	9.84	187	-31
20	16.5	340	5	161	9.84	197	-36
21	78.9	340	22	183	9.84	207	-24
22	78.3	340	22	205	9.84	216	-11
23	48.8	340	14	219	9.84	226	-7
24	54.6	340	15	234	9.84	236	-2
25	25	340	7	241	9.84	246	-5
26	1.6	340	1	242	9.84	256	-14
27	17.3	340	5	247	9.84	266	-19
28	0	340	0	247	9.84	276	-29
29	52.3	340	15	262	9.84	285	-23
30	192.8	340	53	315	9.84	295	20
31	23.3	340	7	322	9.84	305	17
Max							20
Min							86
Volume of Reservoir (m^3/month)							106
Volume of Reservoir (m^3/day)							4

Table 17 Rainwater Storage Volume Building I

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
1	6	300	2	2	9.84	10	-8
2	2.2	300	1	3	9.84	20	-17
3	21.6	300	6	9	9.84	30	-21
4	0	300	0	9	9.84	39	-30
5	5	300	2	11	9.84	49	-38
6	1.6	300	1	12	9.84	59	-47
7	0	300	0	12	9.84	69	-57

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
8	1.2	300	1	13	9.84	79	-66
9	6	300	2	15	9.84	89	-74
10	0	300	0	15	9.84	98	-83
11	23.9	300	6	21	9.84	108	-87
12	64.6	300	16	37	9.84	118	-81
13	132.5	300	32	69	9.84	128	-59
14	13.4	300	4	73	9.84	138	-65
15	37.3	300	9	82	9.84	148	-66
16	13.9	300	4	86	9.84	157	-71
17	0	300	0	86	9.84	167	-81
18	140.6	300	34	120	9.84	177	-57
19	74.8	300	18	138	9.84	187	-49
20	16.5	300	4	142	9.84	197	-55
21	78.9	300	19	161	9.84	207	-46
22	78.3	300	19	180	9.84	216	-36
23	48.8	300	12	192	9.84	226	-34
24	54.6	300	14	206	9.84	236	-30
25	25	300	7	213	9.84	246	-33
26	1.6	300	1	214	9.84	256	-42
27	17.3	300	5	219	9.84	266	-47
28	0	300	0	219	9.84	276	-57
29	52.3	300	13	232	9.84	285	-53
30	192.8	300	47	279	9.84	295	-16
31	23.3	300	6	285	9.84	305	-20
Max							-8
Min							87
Volume of Reservoir (m³/month)							79
Volume of Reservoir (m³/day)							3

Table 18 Rainwater Storage Volume Building K

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	279	2	2	7.92	8	-6
2	2.2	279	1	3	7.92	16	-13
3	21.6	279	5	8	7.92	24	-16
4	0	279	0	8	7.92	32	-24
5	5	279	2	10	7.92	40	-30
6	1.6	279	1	11	7.92	48	-37
7	0	279	0	11	7.92	55	-44
8	1.2	279	1	12	7.92	63	-51
9	6	279	2	14	7.92	71	-57
10	0	279	0	14	7.92	79	-65
11	23.9	279	6	20	7.92	87	-67
12	64.6	279	15	35	7.92	95	-60
13	132.5	279	30	65	7.92	103	-38

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
14	13.4	279	3	68	7.92	111	-43
15	37.3	279	9	77	7.92	119	-42
16	13.9	279	4	81	7.92	127	-46
17	0	279	0	81	7.92	135	-54
18	140.6	279	32	113	7.92	143	-30
19	74.8	279	17	130	7.92	150	-20
20	16.5	279	4	134	7.92	158	-24
21	78.9	279	18	152	7.92	166	-14
22	78.3	279	18	170	7.92	174	-4
23	48.8	279	11	181	7.92	182	-1
24	54.6	279	13	194	7.92	190	4
25	25	279	6	200	7.92	198	2
26	1.6	279	1	201	7.92	206	-5
27	17.3	279	4	205	7.92	214	-9
28	0	279	0	205	7.92	222	-17
29	52.3	279	12	217	7.92	230	-13
30	192.8	279	43	260	7.92	238	22
31	23.3	279	6	266	7.92	246	20
Max							22
Min							67
Volume of Reservoir (m³/month)							90
Volume of Reservoir (m³/day)							3

Table 19 Rainwater Storage Volume Building L

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	340	2	2	10.8	11	-9
2	2.2	340	1	3	10.8	22	-19
3	21.6	340	6	9	10.8	32	-23
4	0	340	0	9	10.8	43	-34
5	5	340	2	11	10.8	54	-43
6	1.6	340	1	12	10.8	65	-53
7	0	340	0	12	10.8	76	-64
8	1.2	340	1	13	10.8	86	-73
9	6	340	2	15	10.8	97	-82
10	0	340	0	15	10.8	108	-93
11	23.9	340	7	22	10.8	119	-97
12	64.6	340	18	40	10.8	130	-90
13	132.5	340	37	77	10.8	140	-63
14	13.4	340	4	81	10.8	151	-70
15	37.3	340	11	92	10.8	162	-70
16	13.9	340	4	96	10.8	173	-77
17	0	340	0	96	10.8	184	-88
18	140.6	340	39	135	10.8	194	-59
19	74.8	340	21	156	10.8	205	-49

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
20	16.5	340	5	161	10.8	216	-55
21	78.9	340	22	183	10.8	227	-44
22	78.3	340	22	205	10.8	238	-33
23	48.8	340	14	219	10.8	248	-29
24	54.6	340	15	234	10.8	259	-25
25	25	340	7	241	10.8	270	-29
26	1.6	340	1	242	10.8	281	-39
27	17.3	340	5	247	10.8	292	-45
28	0	340	0	247	10.8	302	-55
29	52.3	340	15	262	10.8	313	-51
30	192.8	340	53	315	10.8	324	-9
31	23.3	340	7	322	10.8	335	-13
Max							-9
Min							97
Volume of Reservoir (m³/month)							88
Volume of Reservoir (m³/day)							3

Table 20 Rainwater Storage Volume Building M

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	135	1	1	2.88	3	-2
2	2.2	135	1	2	2.88	6	-4
3	21.6	135	3	5	2.88	9	-4
4	0	135	0	5	2.88	12	-7
5	5	135	1	6	2.88	14	-8
6	1.6	135	1	7	2.88	17	-10
7	0	135	0	7	2.88	20	-13
8	1.2	135	1	8	2.88	23	-15
9	6	135	1	9	2.88	26	-17
10	0	135	0	9	2.88	29	-20
11	23.9	135	3	12	2.88	32	-20
12	64.6	135	7	19	2.88	35	-16
13	132.5	135	15	34	2.88	37	-3
14	13.4	135	2	36	2.88	40	-4
15	37.3	135	5	41	2.88	43	-2
16	13.9	135	2	43	2.88	46	-3
17	0	135	0	43	2.88	49	-6
18	140.6	135	16	59	2.88	52	7
19	74.8	135	9	68	2.88	55	13
20	16.5	135	2	70	2.88	58	12
21	78.9	135	9	79	2.88	60	19
22	78.3	135	9	88	2.88	63	25
23	48.8	135	6	94	2.88	66	28
24	54.6	135	6	100	2.88	69	31
25	25	135	3	103	2.88	72	31

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
26	1.6	135	1	104	2.88	75	29
27	17.3	135	2	106	2.88	78	28
28	0	135	0	106	2.88	81	25
29	52.3	135	6	112	2.88	84	28
30	192.8	135	21	133	2.88	86	47
31	23.3	135	3	136	2.88	89	47
Max							47
Min							20
Volume of Reservoir (m³/month)							67
Volume of Reservoir (m³/day)							3

Table 21 Rainwater Storage Volume Building N

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	1028	5	5	20.4	20	-15
2	2.2	1028	2	7	20.4	41	-34
3	21.6	1028	18	25	20.4	61	-36
4	0	1028	0	25	20.4	82	-57
5	5	1028	5	30	20.4	102	-72
6	1.6	1028	2	32	20.4	122	-90
7	0	1028	0	32	20.4	143	-111
8	1.2	1028	1	33	20.4	163	-130
9	6	1028	5	38	20.4	184	-146
10	0	1028	0	38	20.4	204	-166
11	23.9	1028	20	58	20.4	224	-166
12	64.6	1028	54	112	20.4	245	-133
13	132.5	1028	109	221	20.4	265	-44
14	13.4	1028	12	233	20.4	286	-53
15	37.3	1028	31	264	20.4	306	-42
16	13.9	1028	12	276	20.4	326	-50
17	0	1028	0	276	20.4	347	-71
18	140.6	1028	116	392	20.4	367	25
19	74.8	1028	62	454	20.4	388	66
20	16.5	1028	14	468	20.4	408	60
21	78.9	1028	65	533	20.4	428	105
22	78.3	1028	65	598	20.4	449	149
23	48.8	1028	41	639	20.4	469	170
24	54.6	1028	45	684	20.4	490	194
25	25	1028	21	705	20.4	510	195
26	1.6	1028	2	707	20.4	530	177
27	17.3	1028	15	722	20.4	551	171
28	0	1028	0	722	20.4	571	151
29	52.3	1028	43	765	20.4	592	173
30	192.8	1028	159	924	20.4	612	312
31	23.3	1028	20	944	20.4	632	312

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
Max							312
Min							166
Volume of Reservoir (m^3/month)							478
Volume of Reservoir (m^3/day)							16

Table 22 Rainwater Storage Volume Building O

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
1	6	704	4	4	19.2	19	-15
2	2.2	704	2	6	19.2	38	-32
3	21.6	704	13	19	19.2	58	-39
4	0	704	0	19	19.2	77	-58
5	5	704	3	22	19.2	96	-74
6	1.6	704	1	23	19.2	115	-92
7	0	704	0	23	19.2	134	-111
8	1.2	704	1	24	19.2	154	-130
9	6	704	4	28	19.2	173	-145
10	0	704	0	28	19.2	192	-164
11	23.9	704	14	42	19.2	211	-169
12	64.6	704	37	79	19.2	230	-151
13	132.5	704	75	154	19.2	250	-96
14	13.4	704	8	162	19.2	269	-107
15	37.3	704	22	184	19.2	288	-104
16	13.9	704	8	192	19.2	307	-115
17	0	704	0	192	19.2	326	-134
18	140.6	704	80	272	19.2	346	-74
19	74.8	704	43	315	19.2	365	-50
20	16.5	704	10	325	19.2	384	-59
21	78.9	704	45	370	19.2	403	-33
22	78.3	704	45	415	19.2	422	-7
23	48.8	704	28	443	19.2	442	1
24	54.6	704	31	474	19.2	461	13
25	25	704	15	489	19.2	480	9
26	1.6	704	1	490	19.2	499	-9
27	17.3	704	10	500	19.2	518	-18
28	0	704	0	500	19.2	538	-38
29	52.3	704	30	530	19.2	557	-27
30	192.8	704	109	639	19.2	576	63
31	23.3	704	14	653	19.2	595	58
Max							63
Min							169
Volume of Reservoir (m^3/month)							232
Volume of Reservoir (m^3/day)							8

Table 23 Rainwater Storage Volume Building P

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
1	6	225	2	2	5.28	5	-3
2	2.2	225	1	3	5.28	11	-8
3	21.6	225	4	7	5.28	16	-9
4	0	225	0	7	5.28	21	-14
5	5	225	1	8	5.28	26	-18
6	1.6	225	1	9	5.28	32	-23
7	0	225	0	9	5.28	37	-28
8	1.2	225	1	10	5.28	42	-32
9	6	225	2	12	5.28	48	-36
10	0	225	0	12	5.28	53	-41
11	23.9	225	5	17	5.28	58	-41
12	64.6	225	12	29	5.28	63	-34
13	132.5	225	24	53	5.28	69	-16
14	13.4	225	3	56	5.28	74	-18
15	37.3	225	7	63	5.28	79	-16
16	13.9	225	3	66	5.28	84	-18
17	0	225	0	66	5.28	90	-24
18	140.6	225	26	92	5.28	95	-3
19	74.8	225	14	106	5.28	100	6
20	16.5	225	3	109	5.28	106	3
21	78.9	225	15	124	5.28	111	13
22	78.3	225	15	139	5.28	116	23
23	48.8	225	9	148	5.28	121	27
24	54.6	225	10	158	5.28	127	31
25	25	225	5	163	5.28	132	31
26	1.6	225	1	164	5.28	137	27
27	17.3	225	4	168	5.28	143	25
28	0	225	0	168	5.28	148	20
29	52.3	225	10	178	5.28	153	25
30	192.8	225	35	213	5.28	158	55
31	23.3	225	5	218	5.28	164	54
Max							55
Min							41
Volume of Reservoir (m^3/month)							96
Volume of Reservoir (m^3/day)							4

Table 24 Rainwater Storage Volume Building Q

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
1	6	339	2	2	4.32	4	-2
2	2.2	339	1	3	4.32	9	-6
3	21.6	339	6	9	4.32	13	-4
4	0	339	0	9	4.32	17	-8
5	5	339	2	11	4.32	22	-11
6	1.6	339	1	12	4.32	26	-14
7	0	339	0	12	4.32	30	-18

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
8	1.2	339	1	13	4.32	35	-22
9	6	339	2	15	4.32	39	-24
10	0	339	0	15	4.32	43	-28
11	23.9	339	7	22	4.32	48	-26
12	64.6	339	18	40	4.32	52	-12
13	132.5	339	36	76	4.32	56	20
14	13.4	339	4	80	4.32	60	20
15	37.3	339	11	91	4.32	65	26
16	13.9	339	4	95	4.32	69	26
17	0	339	0	95	4.32	73	22
18	140.6	339	39	134	4.32	78	56
19	74.8	339	21	155	4.32	82	73
20	16.5	339	5	160	4.32	86	74
21	78.9	339	22	182	4.32	91	91
22	78.3	339	22	204	4.32	95	109
23	48.8	339	14	218	4.32	99	119
24	54.6	339	15	233	4.32	104	129
25	25	339	7	240	4.32	108	132
26	1.6	339	1	241	4.32	112	129
27	17.3	339	5	246	4.32	117	129
28	0	339	0	246	4.32	121	125
29	52.3	339	15	261	4.32	125	136
30	192.8	339	53	314	4.32	130	184
31	23.3	339	7	321	4.32	134	187
Max							187
Min							28
Volume of Reservoir (m³/month)							215
Volume of Reservoir (m³/day)							8

Table 25 Rainwater Storage Volume Building R and S

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	162	1	1	2.88	3	-2
2	2.2	162	1	2	2.88	6	-4
3	21.6	162	3	5	2.88	9	-4
4	0	162	0	5	2.88	12	-7
5	5	162	1	6	2.88	14	-8
6	1.6	162	1	7	2.88	17	-10
7	0	162	0	7	2.88	20	-13
8	1.2	162	1	8	2.88	23	-15
9	6	162	1	9	2.88	26	-17
10	0	162	0	9	2.88	29	-20
11	23.9	162	4	13	2.88	32	-19
12	64.6	162	9	22	2.88	35	-13
13	132.5	162	18	40	2.88	37	3
14	13.4	162	2	42	2.88	40	2

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
15	37.3	162	5	47	2.88	43	4
16	13.9	162	2	49	2.88	46	3
17	0	162	0	49	2.88	49	0
18	140.6	162	19	68	2.88	52	16
19	74.8	162	10	78	2.88	55	23
20	16.5	162	3	81	2.88	58	23
21	78.9	162	11	92	2.88	60	32
22	78.3	162	11	103	2.88	63	40
23	48.8	162	7	110	2.88	66	44
24	54.6	162	8	118	2.88	69	49
25	25	162	4	122	2.88	72	50
26	1.6	162	1	123	2.88	75	48
27	17.3	162	3	126	2.88	78	48
28	0	162	0	126	2.88	81	45
29	52.3	162	7	133	2.88	84	49
30	192.8	162	26	159	2.88	86	73
31	23.3	162	4	163	2.88	89	74
Max							74
Min							20
Volume of Reservoir (m³/month)							94
Volume of Reservoir (m³/day)							4

Table 26 Rainwater Storage Volume Building T

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	186	1	1	2.88	3	-2
2	2.2	186	1	2	2.88	6	-4
3	21.6	186	4	6	2.88	9	-3
4	0	186	0	6	2.88	12	-6
5	5	186	1	7	2.88	14	-7
6	1.6	186	1	8	2.88	17	-9
7	0	186	0	8	2.88	20	-12
8	1.2	186	1	9	2.88	23	-14
9	6	186	1	10	2.88	26	-16
10	0	186	0	10	2.88	29	-19
11	23.9	186	4	14	2.88	32	-18
12	64.6	186	10	24	2.88	35	-11
13	132.5	186	20	44	2.88	37	7
14	13.4	186	2	46	2.88	40	6
15	37.3	186	6	52	2.88	43	9
16	13.9	186	3	55	2.88	46	9
17	0	186	0	55	2.88	49	6
18	140.6	186	21	76	2.88	52	24
19	74.8	186	12	88	2.88	55	33
20	16.5	186	3	91	2.88	58	33
21	78.9	186	12	103	2.88	60	43

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
22	78.3	186	12	115	2.88	63	52
23	48.8	186	8	123	2.88	66	57
24	54.6	186	9	132	2.88	69	63
25	25	186	4	136	2.88	72	64
26	1.6	186	1	137	2.88	75	62
27	17.3	186	3	140	2.88	78	62
28	0	186	0	140	2.88	81	59
29	52.3	186	8	148	2.88	84	64
30	192.8	186	29	177	2.88	86	91
31	23.3	186	4	181	2.88	89	92
Max							92
Min							19
Volume of Reservoir (m³/month)							111
Volume of Reservoir (m³/day)							4

Table 27 Rainwater Storage Volume Building V

Date	Rainfall (mm)	Roof Area (m²)	Supply Volume (m³)	Supply Accumulation (m³)	Water Usage (m³)	Water Usage Accumulation (m³)	The Difference between Supply and Water Usage (m³)
1	6	155	1	1	4.56	5	-4
2	2.2	155	1	2	4.56	9	-7
3	21.6	155	3	5	4.56	14	-9
4	0	155	0	5	4.56	18	-13
5	5	155	1	6	4.56	23	-17
6	1.6	155	1	7	4.56	27	-20
7	0	155	0	7	4.56	32	-25
8	1.2	155	1	8	4.56	36	-28
9	6	155	1	9	4.56	41	-32
10	0	155	0	9	4.56	46	-37
11	23.9	155	3	12	4.56	50	-38
12	64.6	155	9	21	4.56	55	-34
13	132.5	155	17	38	4.56	59	-21
14	13.4	155	2	40	4.56	64	-24
15	37.3	155	5	45	4.56	68	-23
16	13.9	155	2	47	4.56	73	-26
17	0	155	0	47	4.56	78	-31
18	140.6	155	18	65	4.56	82	-17
19	74.8	155	10	75	4.56	87	-12
20	16.5	155	3	78	4.56	91	-13
21	78.9	155	10	88	4.56	96	-8
22	78.3	155	10	98	4.56	100	-2
23	48.8	155	7	105	4.56	105	0
24	54.6	155	7	112	4.56	109	3
25	25	155	4	116	4.56	114	2
26	1.6	155	1	117	4.56	119	-2
27	17.3	155	3	120	4.56	123	-3
28	0	155	0	120	4.56	128	-8

Date	Rainfall (mm)	Roof Area (m^2)	Supply Volume (m^3)	Supply Accumulation (m^3)	Water Usage (m^3)	Water Usage Accumulation (m^3)	The Difference between Supply and Water Usage (m^3)
29	52.3	155	7	127	4.56	132	-5
30	192.8	155	24	151	4.56	137	14
31	23.3	155	3	154	4.56	141	13
Max							14
Min							38
Volume of Reservoir (m^3/month)							52
Volume of Reservoir (m^3/day)							2

Appendix IV Unit Cost of Activities (HSPK) Bogor City 2023 and 2022

M-20	**1 M' Pasang Talang Plastik PVC U 15 cm (AW)**				
	Talang plastik PVC	m'	1,0500		
	Perlengkapan 35 % harga talang	lot	0,3500		
	Pekerja	org	0,1500		
	Tukang batu	org	0,4000		
	Kepala Tukang	org	0,0250		
	Mandor	org	0,0013		
	Jumlah				
	Dibulatkan				

Figure 21 Pipe and Gutter Installation

Penggalian tanah biasa sedalam 1 m (Dengan Dibuang sejauh 5 km)	Penggalian tanah biasa sedalam 1 m (Tidak Dibuang)	M3	154.524

Figure 22 Soil Excavation Work

DIVISI 1. PERSIAPAN LAPANGAN/SITEWORK	Pengurugan dengan pasir urug	m3	589.413

Figure 23 Sand Backfill Work

Lapis Pondasi bawah Beton Kurus	Lapis Pondasi bawah Beton Kurus	M3	1.296.545

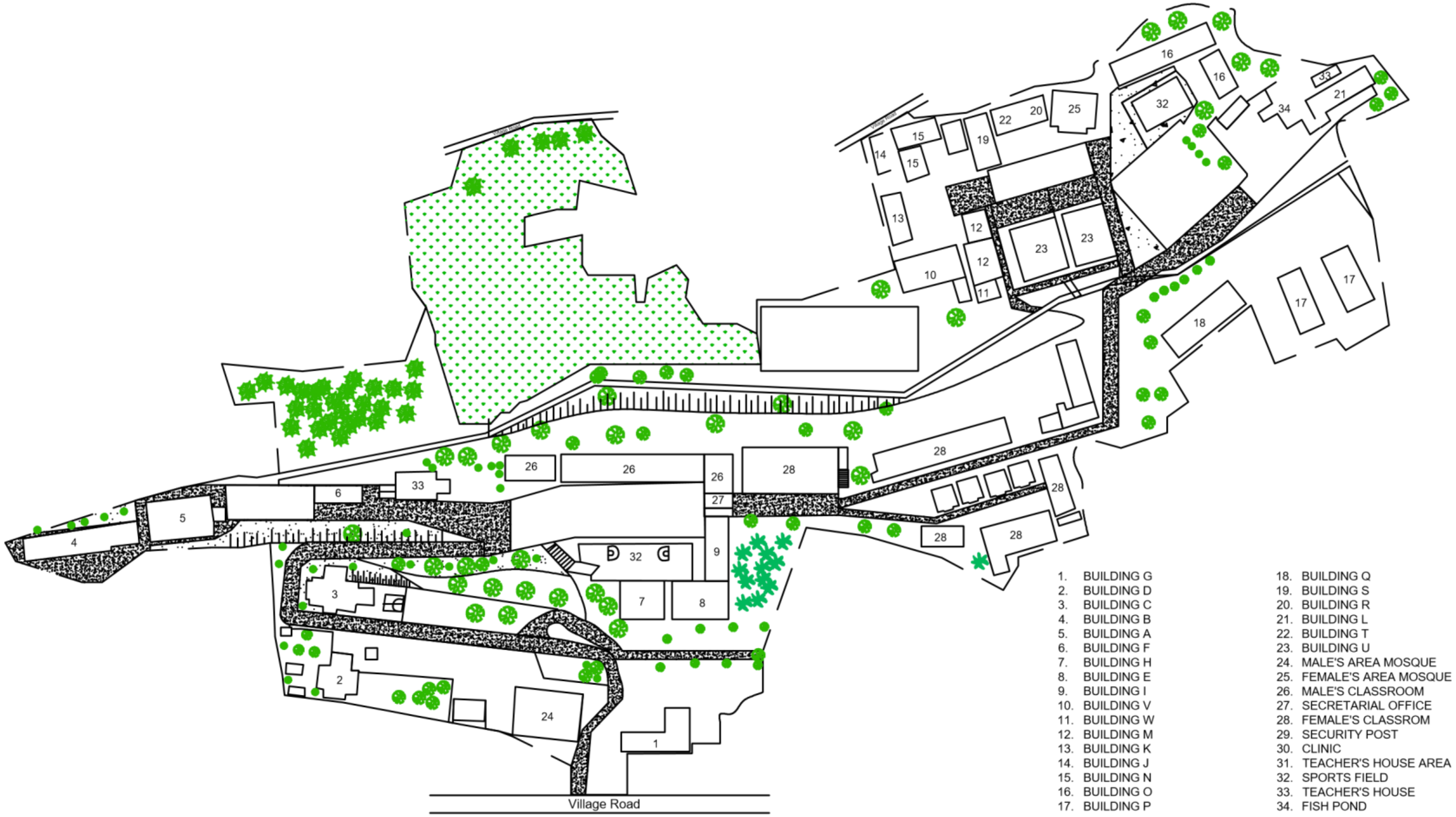
Figure 24 Concrete

DIVISI 4. PEKERJAAN ARSITEKTUR	Pemasangan 1 m2 bekisting untuk dinding	m2	730.792

Figure 25 Wall Formwork

DIVISI 4. PEKERJAAN ARSITEKTUR	Pemasangan 1 m2 lantai keramik 30x30	m2	416.482

Figure 26 Ceramic Installation



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FACULTY OF CIVIL ENGINEERING PLANNING AND GEO ENGINEERING
INSTITUT TEKNOLOGI SEPULUH NOPEMBER

TITLE

LAYOUT OF RAINWATER HARVESTING

DRAFTER

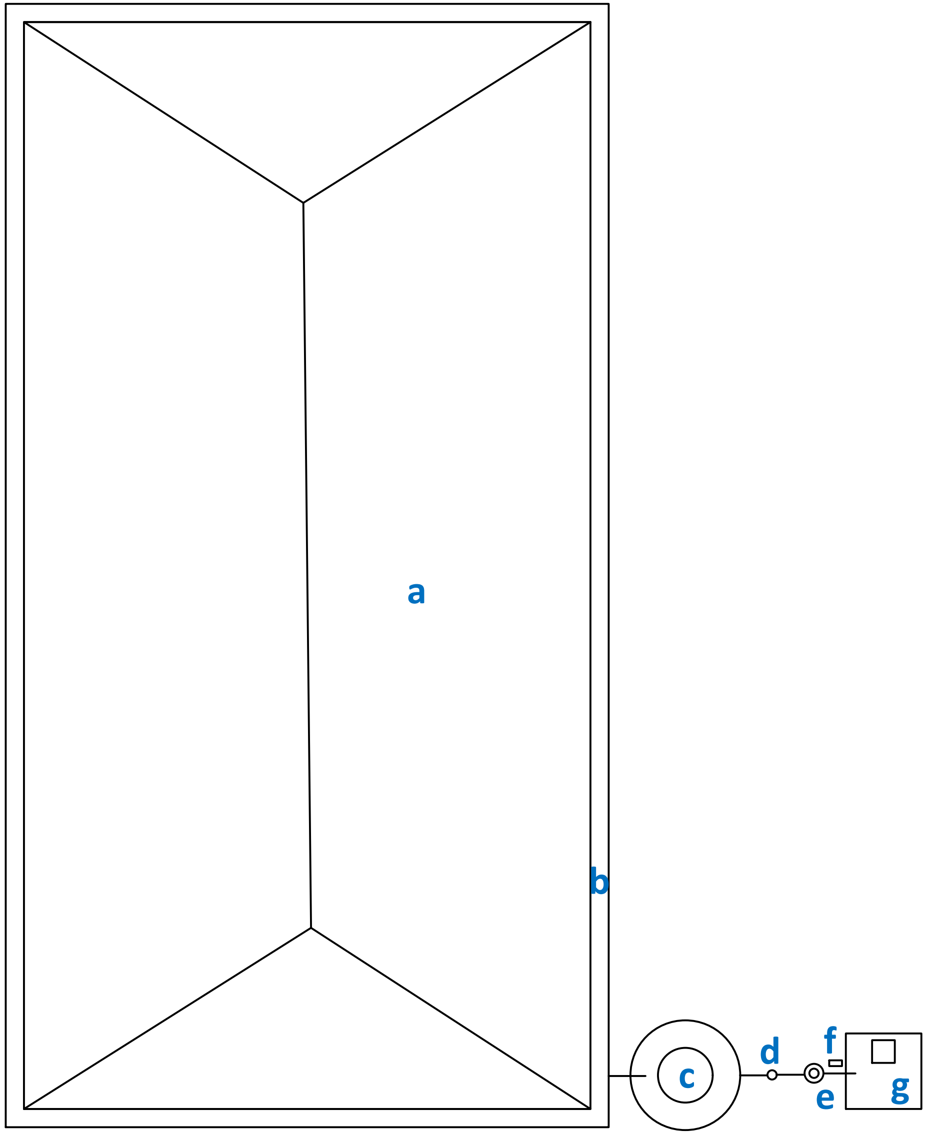
ANNISA SOFIA AFIFAH
5014201120

ADVISOR

AINUL FIRDATUN NISAA, S.T., M.SC.
NIP. 1993202012060

LEGEND

SCALE	FIGURE
1:2500	1 of 8



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LAYOUT OF RAINWATER HARVESTING

DRAFTER

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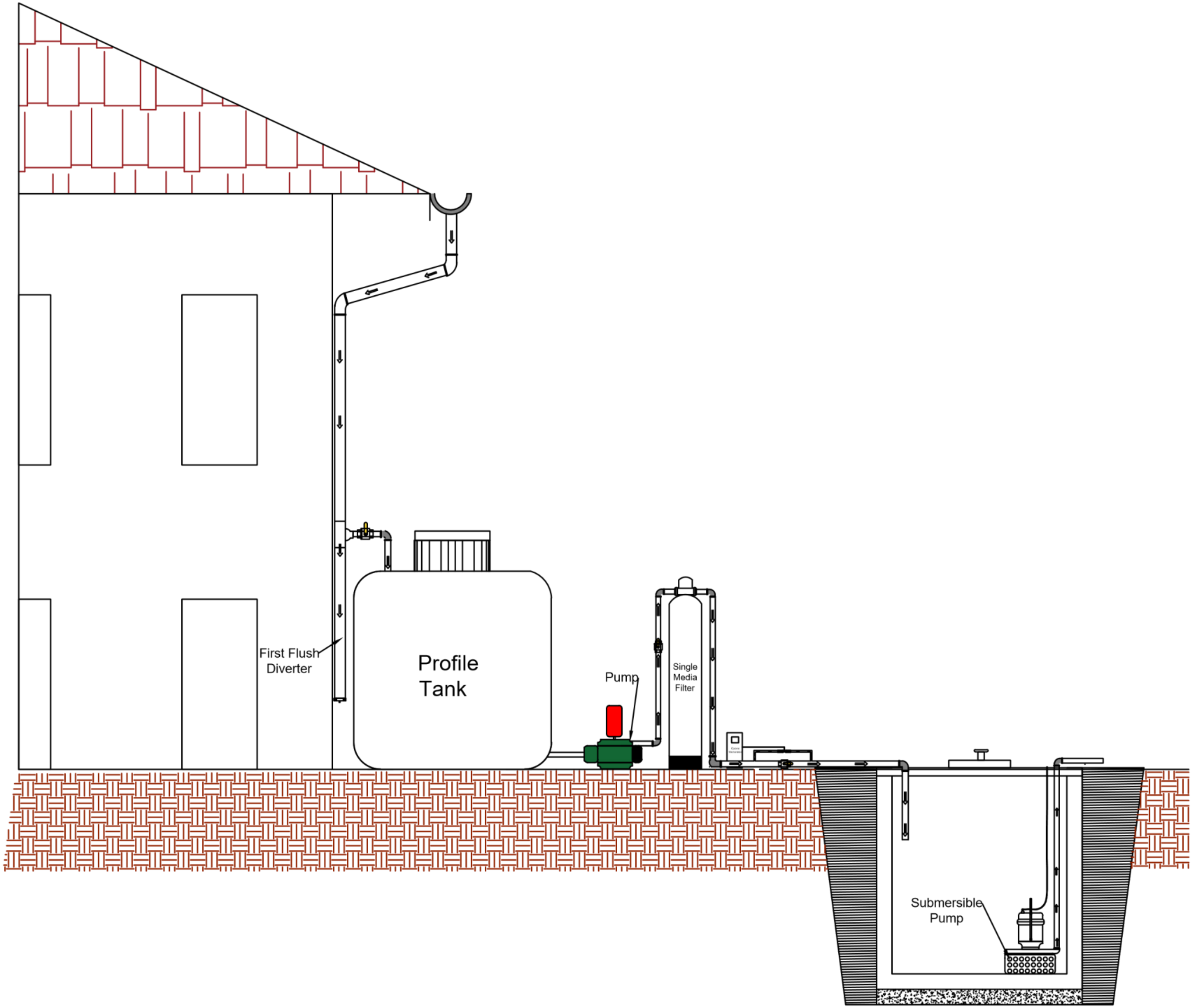
DESCRIPTION

a : Catchment area (Roof)
b : Gutter
c : Profile Tank
d : Pump
e : Single media filter
f : Ozone generator
g : Ground Reservoir

SCALE	FIGURE
1:100	2 of 8



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DEPARTEMENT OF ENVIRONMENTAL ENGINEERING
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INSTITUT TEKNOLOGI SEPULUH NOPEMBER

TITLE

SCHEME OF RAINWATER HARVESTING SYSTEM

DRAFTER

ANNISA SOFIA AFIFAH
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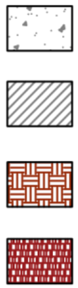
LEGEND



CONCRETE

COMPACTED SAND

SOIL

ROOFTILE

SCALE	FIGURE
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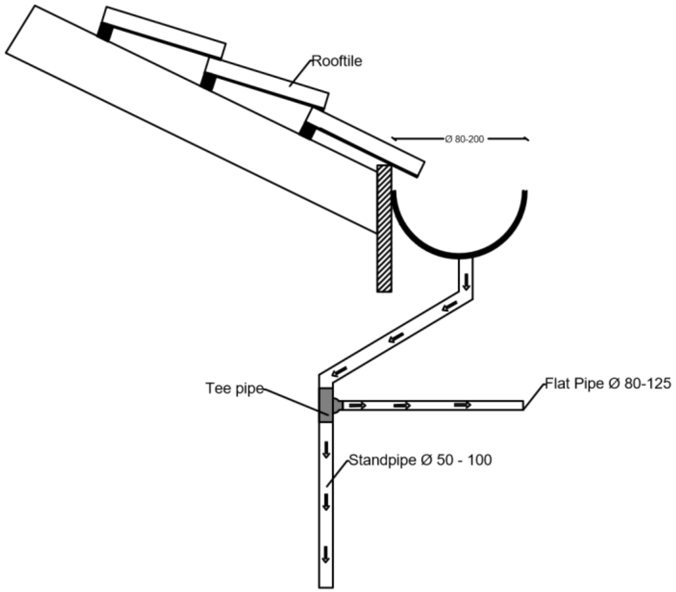
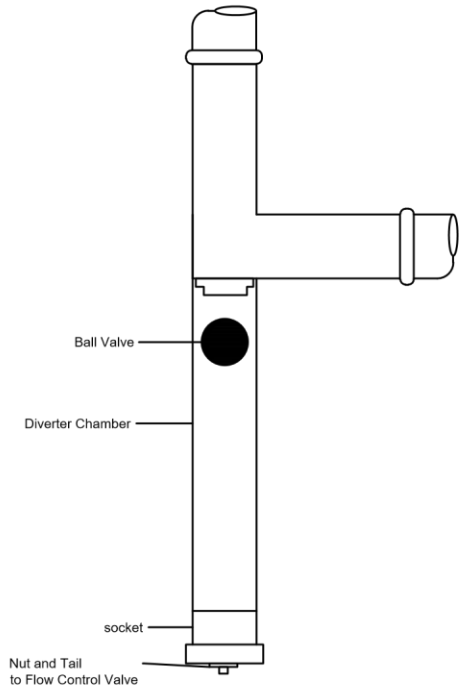


TYPICAL PICTURE OF GUTTER AND PIPING SYSTEM

NO SCALE



TYPICAL PICTURE OF FIRST FLUSH DIVERTER

NO SCALE

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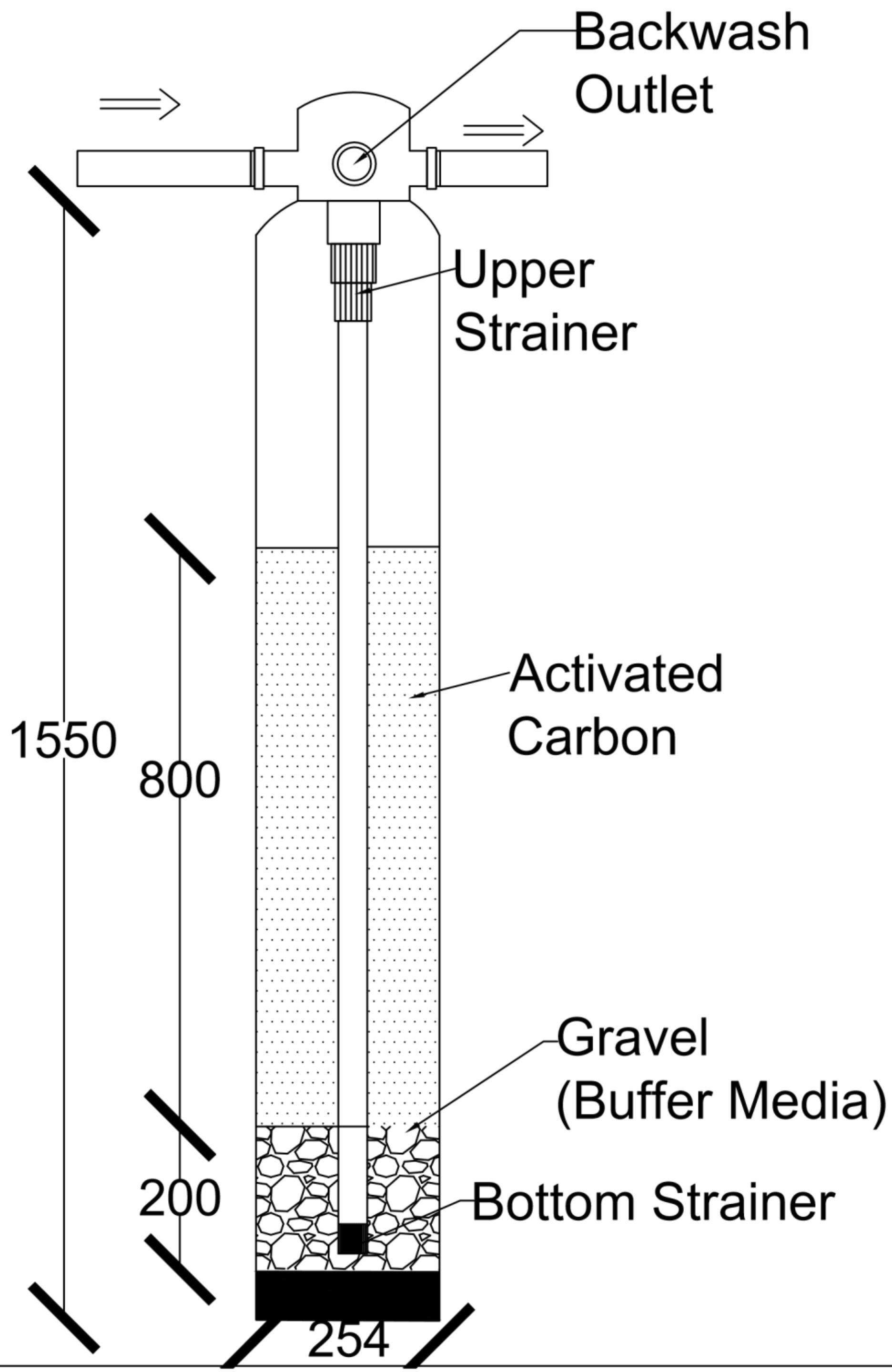
LEGEND

SCALE	FIGURE
	4 of 8



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TITLE

DETAIL OF FILTER UNIT

DRAFTER

ANNISA SOFIA AFIFAH
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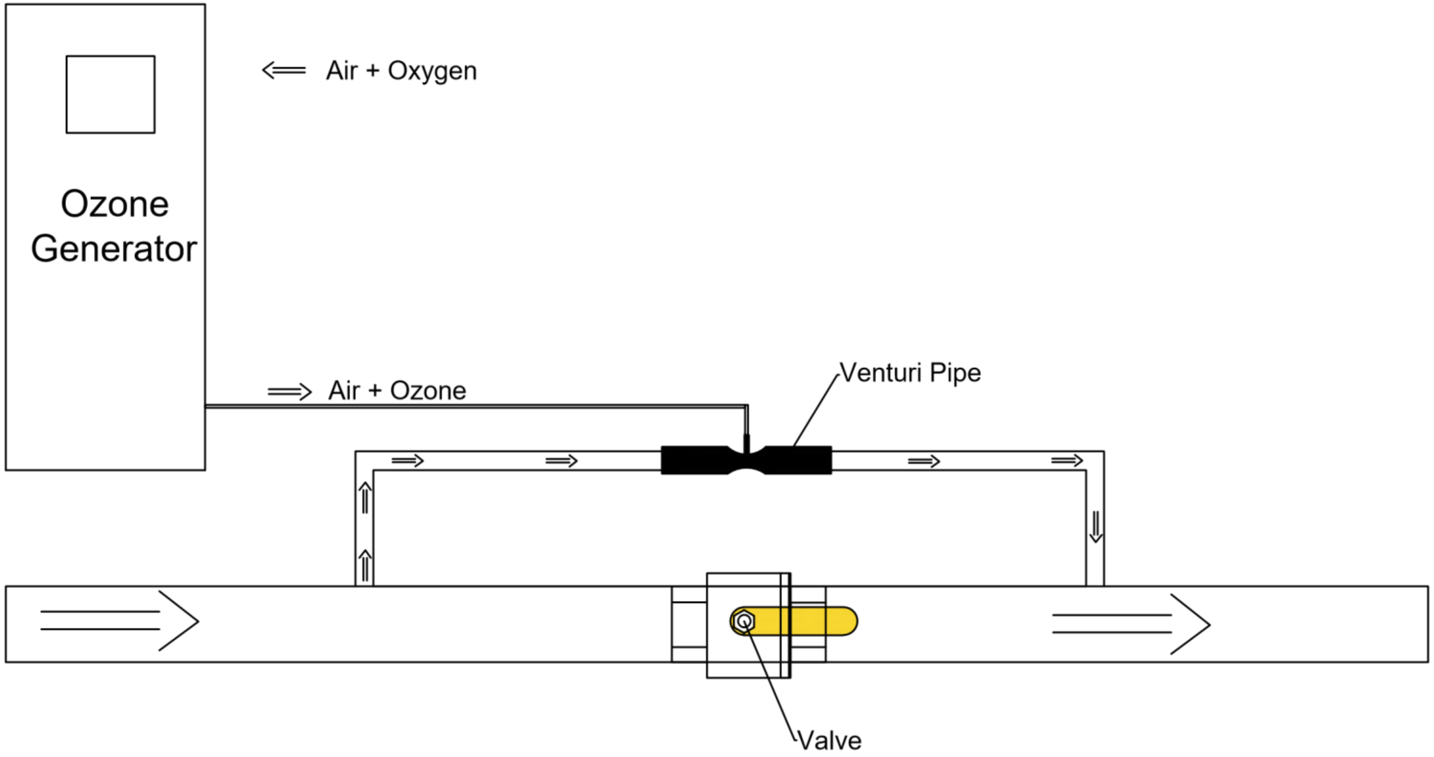
DESCRIPTION

SCALE	FIGURE
1:10	5 of 8



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TITLE

TYPICAL PICTURE OF OZONIZATION

DRAFTER

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LEGEND

SCALE	FIGURE
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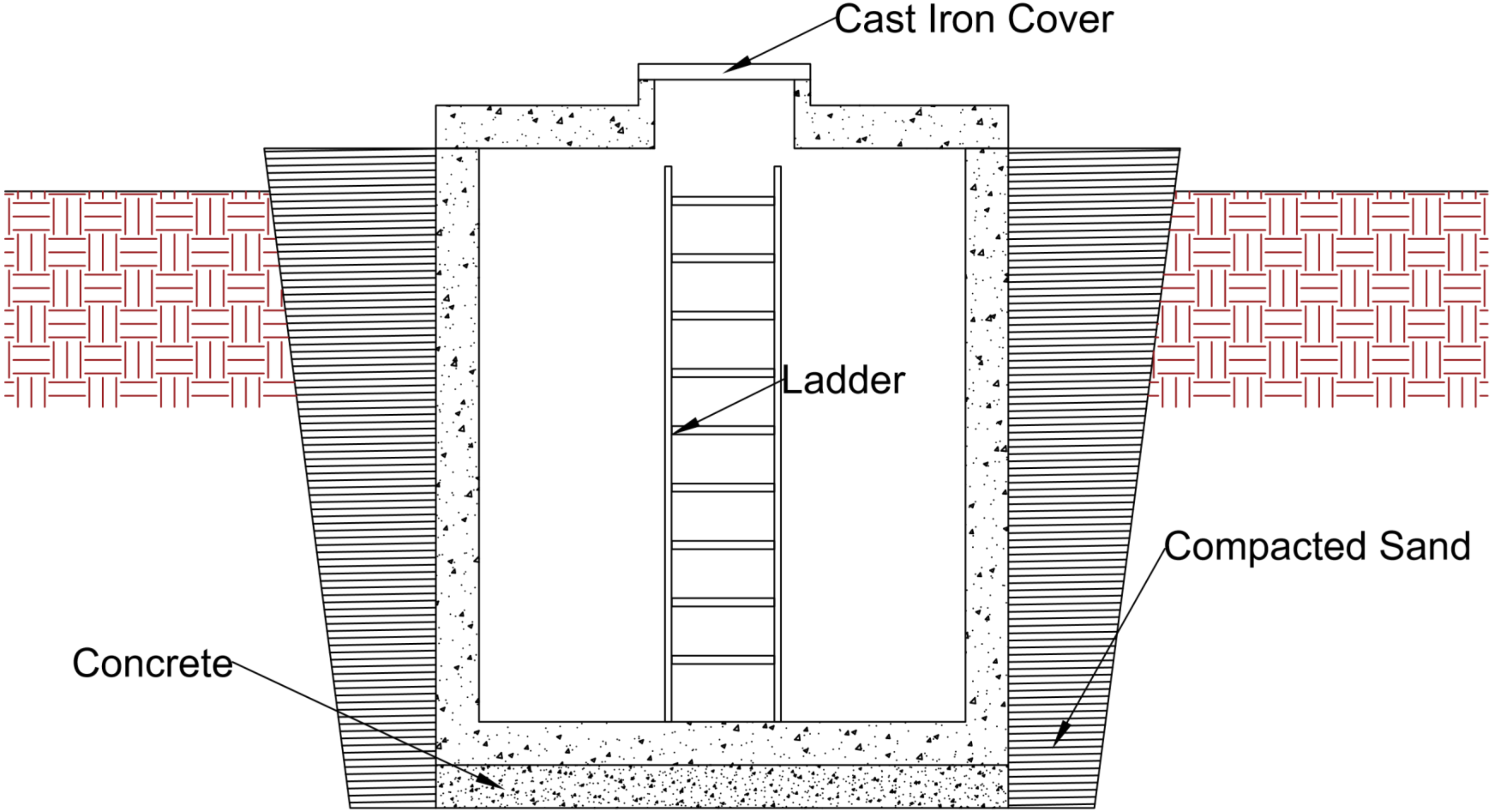

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TYPICAL PICTURE OF GROUND RESERVOIR

DRAFTER

ANNISA SOFIA AFIFAH
5014201120

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LEGEND

SCALE	FIGURE
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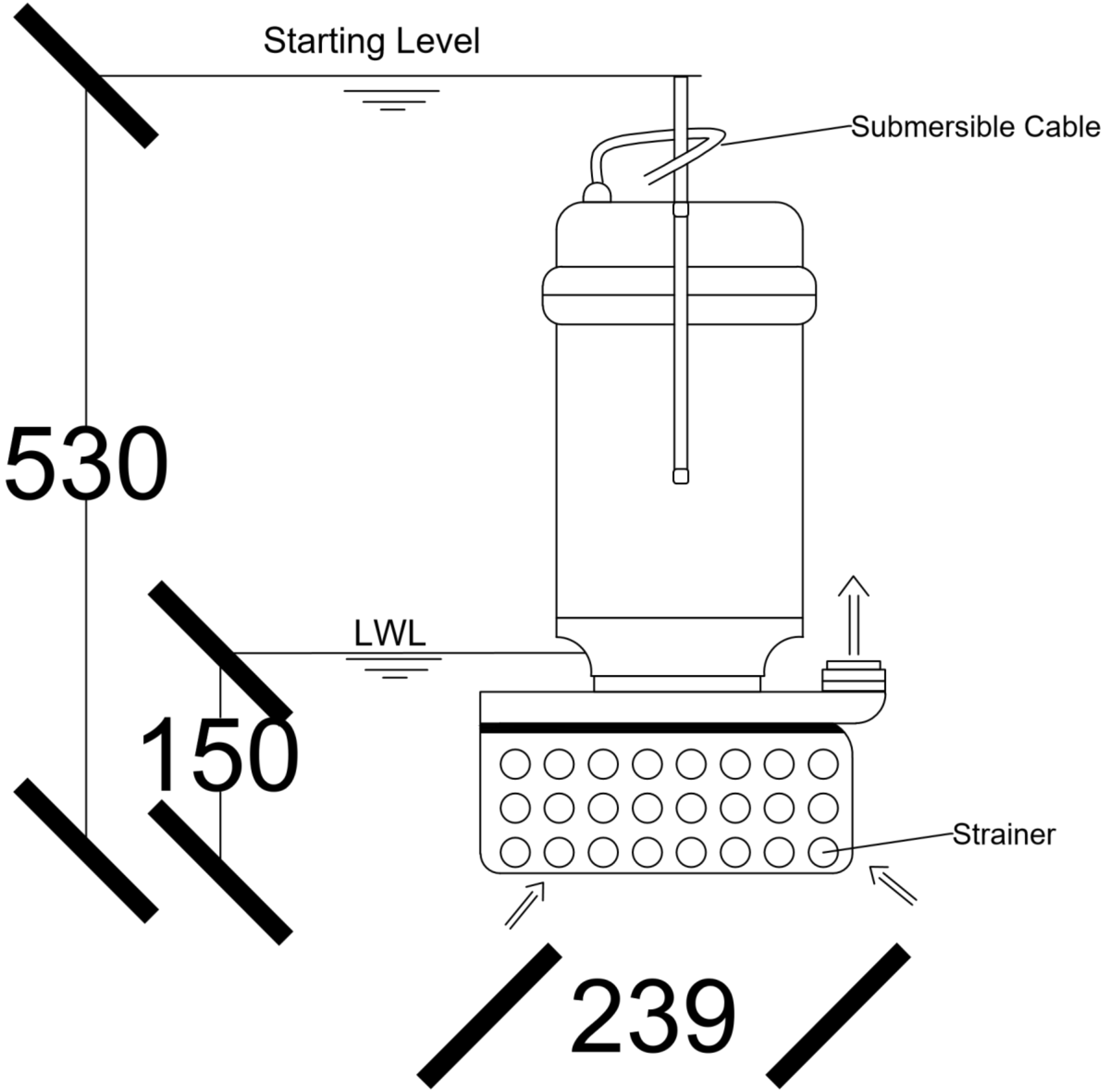

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INSTITUT TEKNOLOGI SEPULUH NOPEMBER

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LAYOUT OF RAINWATER HARVESTING

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LEGEND

SCALE	PAGE
1:100	8 of 8

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