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Planning of PAMSIMAS Drinking Water Production Unit in Kamplas Village, Abung Barat District, Lampung Utara Regency

Perencanaan Unit Produksi Air Minum PAMSIMAS Desa Kamplas, Kecamatan Abung Barat, Kabupaten Lampung Utara

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ABSTRAK

Akses terhadap air minum bersih di Kabupaten Lampung Utara masih terbatas, hanya 53,28% rumah tangga yang terlayani. Di Desa Kamplas, air baku dari sumur bor melebihi batas yang ditetapkan oleh PERMENKES No. 2 Tahun 2023, untuk kekeruhan (3.97 NTU), warna (32 TCU), besi (0.267 mg/L), mangan (0.281 mg/L), dan total koliform (130 CFU/100 mL), sehingga diperlukan pengolahan sebelum didistribusikan ke masyarakat. Studi ini bertujuan untuk menentukan konfigurasi pengolahan yang sesuai dengan karakteristik air baku Desa Kamplas dan layak untuk dioperasikan oleh masyarakat. Desain disajikan sebagai detailed engineering desain (DED), bill of quantity (BOQ), dan rencana anggaran biaya. Desain dikembangkan dalam empat tahap: karakterisasi air baku terhadap standar air minum nasional, proyeksi kebutuhan air direncanakan untuk lima tahun, pemilihan konfigurasi pengolahan melalui analisis multi-kriteria dan pengisian pembobotan oleh pemangku kepentingan, dan penentuan ukuran unit diikuti dengan estimasi biaya. Hasil yang diperoleh menunjukkan bahwa konfigurasi pengolahan air minum Alternatif 4 (bak penampung awal - filtrasi pasir lambat - disinfeksi - reservoir eksisting) memperoleh skor tertinggi, karena filtrasi pasir lambat bekerja dengan andal pada air tanah dengan kekeruhan rendah dan tidak memerlukan koagulan, sehingga mengurangi biaya operasional dan kebutuhan keterampilan operator pada skala desa. Unit ini akan melayani 1,558 orang hingga tahun 2028 dengan estimasi biaya sebesar Rp 1,110,048,239,-.

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ABSTRACT

Access to safe drinking water in Lampung Utara Regency remains limited, with only 53.28% of households served. In Kamplas Village, raw water from a borehole exceeds the limits of Ministry of Health No. 2 of 2023 for turbidity (3.97 NTU), color (32 TCU), iron (0.267 mg/L), manganese (0.281 mg/L), and total coliform (130 CFU/100 mL), so treatment is required before distribution. This study aims to determine a treatment configuration suited to the raw water characteristics of Kamplas Village and feasible for community-based operation. The design is delivered as a detailed engineering design (DED), a bill of quantity (BOQ), and a cost estimate. The design was developed in four stages: raw water characterization against the national drinking water standard, demand projection over a five-year period, selection of the treatment configuration through weighted multi-criteria scoring by stakeholders, and unit sizing followed by cost estimation. The results showed that drinking water treatment configuration scheme Alternative 4 (storage tank - slow sand filtration - disinfection - existing reservoir) obtained the highest weighted score, as slow sand filtration performs reliably on low-turbidity groundwater and requires no coagulant, reducing operating cost and operator skill requirements at village scale. The unit will serve 1,558 people by 2028 at a cost estimate of IDR 1,110,048,239,-.

1. INTRODUCTION

1.1 Background

Population growth increases the demand for safe drinking water. In Lampung Province, only 56.7% of households have access to safe drinking water, and in Lampung Utara Regency the figure is 53.28% (National Statistics Agency, 2023). Extending piped supply to all villages is restricted by topography, distance to sources of raw water and operational constraints. The Community Based Drinking Water Supply Programme (PAMSIMAS) has thus become the major instrument to serve villages beyond the reach of piped networks and has been shown to enhance local ownership and continuity of facility management (Daniel et al., 2021). Furthermore, in Lampung Utara Regency only 53.28% of households have access to safe drinking water, indicating a need to improve access to safe drinking water in the region (National Statistics Agency, 2023). Kamplas Village, Abung Barat District, Lampung Utara Regency, was chosen as the location for the Drinking Water Production Unit Planning for several reasons, including the existing conditions in Kamplas Village, where there is no piped drinking water network, a lack of drinking water supply facilities and infrastructure, and raw water quality that does not meet standards. During an initial inspection by the Kamplas Village PAMSIMAS team in Fiscal Year 2024, it was found that several water quality parameters exceeded quality standards, namely turbidity of 3.97 NTU, color at 32 TCU, iron (Fe) at 0.267 mg/L, manganese (Mn) at 0.281 mg/L, and total coliform at 130 CFU/100 mL (Environmental Laboratory Lampung Province, 2024).

Moreover, many village scale PAMSIMAS units are built as abstraction and distribution schemes, with treatment omitted or adopted generically rather than derived from the measured raw water quality (Heston et al., 2022). Units are consequently commissioned while still delivering water above the quality standard. Studies combining raw water characterization, transparent multi criteria selection of the treatment train, and a costed engineering design for a single community scale unit are still limited; this study addresses that gap. The contribution of this study is the integration of three steps that are usually carried out separately: laboratory characterization of the raw water, multi criteria selection of the treatment configuration involving academic, government, and community stakeholders, and a DED costed through a BOQ and cost estimate producing a design that is compliant, verifiable in terms of cost, and operable by the village. To address the issue of safe drinking water availability in Kamplas Village, advanced water treatment is required to ensure that the raw water meets quality standards and is safe for consumption. In addition, this will support the four aspects of drinking water in Kamplas Village, namely quality, quantiity, continuity, and affordability (i.e. kualitas, kuantitas, kontinuitas, dan keterjangkauan) (4K). Therefore, the construction of a PAMSIMAS drinking water production unit is planned, which includes a detailed engineering design (DED), bill of quantity (BOQ), and cost estimate. Through this plan, the community- based drinking water production unit can meet the safe drinking water needs of the residents of Kamplas Village.

The purpose of this study is to select the most appropriate of four candidate treatment configurations for Kamplas Village's raw water quality considering the technical, economic and environmental criteria, and to provide a fully costed and implementable design of the village PAMSIMAS drinking water production unit. The design was based on the sequence of population and water demand projections, raw water analysis, selection of treatment configuration, detailed unit design, and cost estimation. In this case, this study will develop a plan for the PAMSIMAS Drinking Water Production Unit in Kamplas Village, Abung Barat District, Lampung Utara Regency.

2. METHOD

This is an engineering design study not an experimental one. Primary data comprises laboratory tests of raw water quality and field measurement at the site; all subsequent steps are design calculations according to national standards and guidelines.

2.1 Planning Location

The location of the PAMSIMAS Drinking Water Production Unit planning study is in Kamplas Village, Abung Barat District, Lampung Utara Regency, Lampung Province. The administrative map of Kamplas Village and the planning location are shown in **Figure 1** and **Figure 2**.

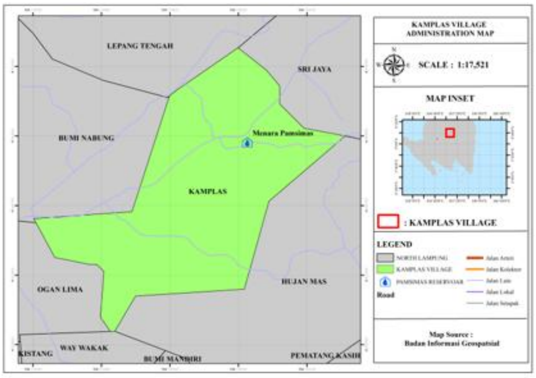

Figure 1. Kamplas village administrative map

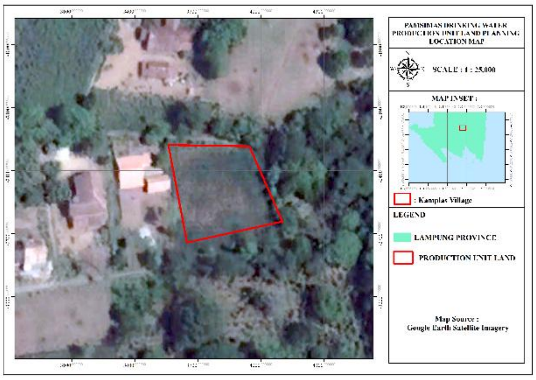

Figure 2. Land allocation for production units

The raw water source used comes from groundwater (borehole) with coordinates 4°50'28.07"S and 104°44'12.61" E. The borehole was drilled by the PAMSIMAS team in the 2024 fiscal year and is planned to serve the entire community of Kamplas Village during the five-year projection period.

2.2 Data Processing and Analysis Method

The planning of the PAMSIMAS drinking water production unit is based on raw water quality data, followed by calculations of population projections, water demand projections, selection of alternative drinking water treatment schemes, detailed engineering design (DED) planning, and determination of the bill of quantity (BOQ) and cost estimate for the PAMSIMAS drinking water production unit in Kamplas Village. The planning process is as follows:

1. Population projection
   The population was projected for a period of five years using arithmetic, geometric and least squares methods. The method with the least standard deviation was adopted following Ministry of Public Works (2007).

2. Water demand projection
   Projected water demand includes domestic water demand, non-domestic water demand, average discharge, leakage discharge, total discharge, and maximum daily discharge (Ministry of Public Works, 2007). These results are calculated based on the projected population for the next five years.

3. Raw water quality analysis
   The parameters tested for raw water quality include temperature, TDS, turbidity, color, odor, pH, nitrate, nitrite, Cr6+, iron, manganese, residual chlorine, arsenic, cadmium, lead, fluoride, aluminum, *E. coli*, and total coliform. The data will be compared with drinking water quality standards set out in the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023. Raw water quality data is used to create alternative drinking water treatment configuration schemes so that the designed treatment unit can effectively remove contaminants in the raw water.

4. Selection of the treatment configuration
   The selection of alternative water treatment schemes was made using a scoring method involving stakeholders in the field of drinking water treatment to assign scores based on technical, economic, and environmental aspects (Kusumadewi et al., 2022). The configuration was selected by weighted scoring and three criteria were evaluated: technical suitability (weight 50%): removal of the exceeding parameters, compliance with design standards, land requirement; economic feasibility (30%): construction cost, O&M cost, local availability of chemicals and spares; and environmental performance (20%): residual generation and energy demand. Respondents rated each criterion from 1 (very poor) to 5 (very good). The total score for each alternative is $S = \sum(wi\ x\ xi)$, where wi is the weight of criterion i and xi is the mean respondent score (Dewalkar & Shastri, 2022). Respondents consisted of three people from academia, government settlement infrastructure agency, and village government.

5. Detailed engineering design (DED)
   A five-year horizon (2024 - 2028) follows Ministry of Public Works (2007) for simple community- scale systems, whose financing and management rest with the village. Unit sizing follows SNI 3981:2008 for the slow sand filter, Ministry of Public Works (2007) for the storage tank and reservoir, and Crittenden et al. (2012) for disinfection contact time.

6. Calculation of bill of quantity (BOQ) and cost estimate
   The BOQ and cost estimate were derived from the DED specifications using the unit price analysis in accordance with Directorate General of Construction Development (AHSP, 2024) and the basic unit price refers to Department of Highways and Construction Lampung Province (HSPK, 2023).

3. RESULTS AND DISCUSSION

3.1 Population Projection

Population projections were calculated using arithmetic, geometric and least squares methods. The most appropriate projection method was selected based on the smallest standard deviation. This statistic reflects the dispersion of projected values from the observed trend. A smaller standard deviation indicates that the projected values are closer to the historical population pattern and therefore provide a more reliable basis for long term planning. (Lomax et al., 2022; Stańczyk et al., 2022). The following is a summary of the standard deviation values, which can be seen in **Table 1**.

Table 1. Recapitulation of standard deviation values

Method	Result
Least Square	317.86
Arithmetic	177.20
Geometric	175.10

After calculating the smallest standard deviation value, it was found that the standard deviation in the geometric method was the smallest, namely 175.10, and this was then used to project the population in the next five years. The geometric method gave the smallest standard deviation (i.e., 175.10, versus 177.20 arithmetic and 317.86 least squares), indicating compounding rather than linear growth, typical of a village growing from a small base through natural increase.

Table 2. Results of 5 years population projection calculations

Year	Year Of-	Population Results (person)
2024	1	1140
2025	2	1232
2026	3	1333
2027	4	1441
2028	5	1558

The population projection calculations for the next five years can be seen **in Table 2.** Based on the results obtained from the population projection calculations for the next five years, the population of Kamplas Village at the end of the planning period will be 1,558 people.

3.2 Water Demand Projection

The projected water demand is calculated based on the estimated population of 1,558 people at the end of the planning period (2028). Before calculating the water demand, the category based on the population was first determined, which is in accordance with the city category based on the population released by Directorate General of Human Settlements (2000). Kamplas Village is classified as a Category V village due to its population of 1,558. The projected water demand calculation can be seen in **Table 3**.

Table 3. Calculation of water requirement projection

Type	Result
Projected Year (Next 5 years)	2028
Population (In the 5th year) (People)	1558
Daily Water Demand (L)	2077.36
Domestic water demand (m^3/s)	0.02
Non-Domestic water demand (m^3/s)	0.0072
Total water discharge (m^3/s)	0.031
Leakage discharge (m^3/s)	0.0078
Average discharge (m^3/s)	0.039
Maximum daily discharge (m^3/s)	0.036

Based on **Table 3**, the water demand in Kamplas Village can be seen in detail, which will later be used to calculate the processing unit dimensions at the Kamplas Village PAMSIMAS Drinking Water Production Unit.

3.3 Raw Water Quality Analysis

The raw water used in this plan is groundwater (boreholes). To determine the quality of the raw water to be used, it is necessary to test it. The following is the raw water quality data, as shown in **Table 4**.

Table 4. Result of raw water quality test

No	Parameters	Test Result	Max Limit	Unit	Desc
			Physique		
1	Temperature	27.3	Air temp ± 3	°C	Compliant
2	Total Dissolve Solid	77	<300	mg/L	Compliant
3	Turbidity	3.97	<3	NTU	Exceed
4	Color	32	10	TCU	Exceed
5	Odor	Odorless	Odorless	-	Compliant
			Chemical		
6	pH	7	6.5-8.5	-	Compliant
7	Nitrate (NO_3)	0.56	20	mg/L	Compliant
8	Nitrite (NO2)	0.01	3	mg/L	Compliant
9	Chromium (Cr^{6+})	<0.001	0.01	mg/L	Compliant
10	Iron (Fe)	0.267	0.2	mg/L	Exceed
11	Manganese (Mn)	0.281	0.1	mg/L	Exceed
12	Residual Chlorine	0	0.2-0.5	mg/L	Compliant
13	Arsen (Ar)	<0.02	0.01	mg/L	Compliant
14	Cadmium (Cd)	<0.001	0.003	mg/L	Compliant
15	Lead (Pb)	<0.001	0.01	mg/L	Compliant
16	Fluoride (F)	<0.098	1.5	mg/L	Compliant
17	Aluminum (Al)	0.074	0.2	mg/L	Compliant
			Microbiology		
18	Escherichia Coli	0	0	CFU/100 mL	Compliant
19	Total Coliform	130	0	CFU/100 mL	Exceed

**Drinking water quality standards (Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023)*

Based on the results of the raw water quality testing listed in **Table 4**, there are five parameters that exceed the safe limits of the quality standards set out in the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023. These parameters are turbidity 3.97 NTU, color 32 TCU, iron (Fe) 0.267 mg/L, manganese (Mn) 0.281 mg/L, and total coliform 130 CFU/100 mL (Environmental Laboratory Lampung Province, 2024). The exceedances are concurrent. The color (32 TCU) and part of the turbidity (3.97 NTU) are due to the redox reactions of manganese and iron in the reduced groundwater, which form particulates upon contact with air. Turbidity, color, Fe, and Mn can therefore be dealt with together by one physical barrier preceded by storage. The coliform count (130 CFU/100 mL) requires a separate disinfection barrier. Based on the results of raw water quality tests, the water is not yet safe to drink, so further treatment of the raw water is needed so that the people of Kamplas Village can drink it safely.

3.4 Selection of Alternative Drinking Water Treatment Configuration Schemes

Alternative drinking water treatment configuration schemes are determined based on raw water quality data, with the aim of ensuring that the drinking water treatment schemes developed can effectively degrade pollutants in the raw water. The following alternative drinking water treatment configuration schemes can be seen in **Table 5**.

Table 5. Alternative scheme of drinking water treatment configuration

Alternative	Alternative scheme of drinking water treatment configuration
Alternative 1	Storage tank - Coagulation - Rapid Sand Filtration - Disinfection - reservoir
Alternative 2	Storage tank - Coagulation - Slow Sand Filtration - Disinfection - reservoir
Alternative 3	Storage tank - Rapid Sand Filtration - Disinfection - reservoir
Alternative 4	Storage tank - Slow Sand Filtration - Disinfection - reservoir

The four alternative schemes were developed based on Water Treatment Principles and Design, Third Edition (Crittenden et al., 2012). An alternative water treatment scheme was selected for use in the drinking water production unit. The selection was made using a scoring method involving several respondents who were stakeholders in the field of drinking water treatment. The role of the respondents was to assign scores to each aspect to be assessed in order to select the alternative to be used in the PAMSIMAS drinking water production unit. The following are the respondents who assigned scores in the selection of alternative drinking water treatment schemes, as shown in **Table 6**.

Table 6. Respondents

No	Area of Expertise	Agency	Position
1	Academia	Institut Teknologi Sumatera	Assistant Professor
2	Experts	Balai Prasarana Permukiman Wilayah Lampung	Community Facilitator for PAMSIMAS Drinking Water Engineering
3	Local Community	Kamplas Village Government	Village Head

Table 7 gives a summarized weighted score from the three respondents. **Alternative 4** (storage tank - slow sand filtration - disinfection - reservoir) received the highest total score and was selected (**Figure 3**). Slow sand filtration was chosen because the raw water turbidity (3.97 NTU) falls well within the range that the process can reliably treat without pre-coagulation and because the biologically active surface layer removes color, oxidized Fe and Mn and coliform simultaneously. Chlorine was selected due to its local availability, measurable residual, and ease of dosing. The limitations are recognized: the low filtration rate requires a larger footprint, which is accommodated within the allocated land; the bed requires periodic scraping and resanding, which is included in the O&M plan; and disinfection of by-product formation is limited by placing chlorination downstream of filtration, where precursors have been removed.

Table 7. Recapitulation of the results of filling in the weighted scores

Num	Aspect	Weighted Score of Alternative Drinking Water Treatment			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
1	Removal efficiency	4	5	3	4
2	Flexibility of the treatment system to fluctuations in raw water quality	4	3	3	5
3	Construction (material availability and potential damage)	5	3	2	4
4	Unit operation and maintenance	2	3	4	5
5	Land area	3	2	3	5
6	Unit operation and maintenance costs	2	2	2	4
7	Construction costs	1	2	5	5
8	Ecological balance, environmental carrying capacity, and land use	2	3	4	5
Score Result		23	23	26	**37**
Recapitulation of Election Results				**Alternative 4**	

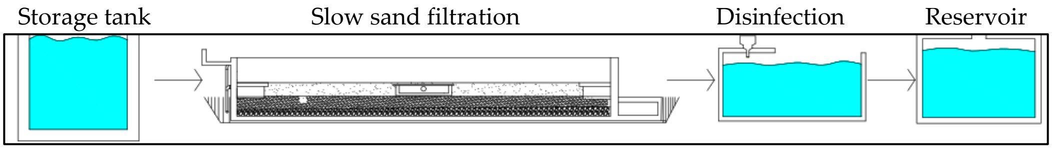

Figure 3. Selected drinking water treatment unit scheme

3.5 Detailed Engineering Design (DED) Planning

The planning of PAMSIMAS drinking water production units will be carried out by calculating the DED of each treatment unit. The following are the DED calculations for each drinking water treatment unit in the PAMSIMAS drinking water production unit.

1. Storage tank unit
   The storage tank is used as an equalization tank for storing raw water before the drinking water treatment process and, at the same time, it guarantees the stability of the inflow to the downstream treatment units (Wang et al., 2023). The design includes two storage tanks to enhance operational reliability and reduce fluctuations in the quantity and quality of raw water, given that the water source is groundwater,

which can vary in yield and physicochemical characteristics due to seasonal recharge, pumping rates, and aquifer conditions (Ahmed et al., 2022). Recent studies have shown that equalization or storage tanks play an essential role in stabilizing influent characteristics, reducing hydraulic shock loads, and improving the overall performance and resilience of water treatment systems, particularly for decentralized and small-scale drinking water facilities (Xu et al., 2022 and Thomas et al., 2023). The design criteria refers to Ministry of Public Works (2007) and the design calculations are presented in **Table 8**.

Table 8. Design criteria and dimensions of the storage tank unit

Type	Calculation Result	Unit	Design Criteria	Desc
		Unit Dimension		
Length	5	m	1:1 Or 2:1	✓
Width	2	m		✓
Height	2.50	m	1 – 1.50 M	✓
		Storage Tank Piping		
Inlet	50	mm	-	✓
Outlet	50	mm	-	✓
		Number Of Unit		
Tank	2	Unit	Minimum 1	✓
		Storage Tank Head Loss		
Head Loss	0.000028	m	-	✓

The detailed engineering design (DED) with the longitudinal section of the storage tank is shown **in Figure 4**. The storage tank is fitted with inlet pipe, outlet pipe, access stairs, and manhole for carrying out routine inspections, cleaning and maintenance to ensure long term operational safety and service reliability.

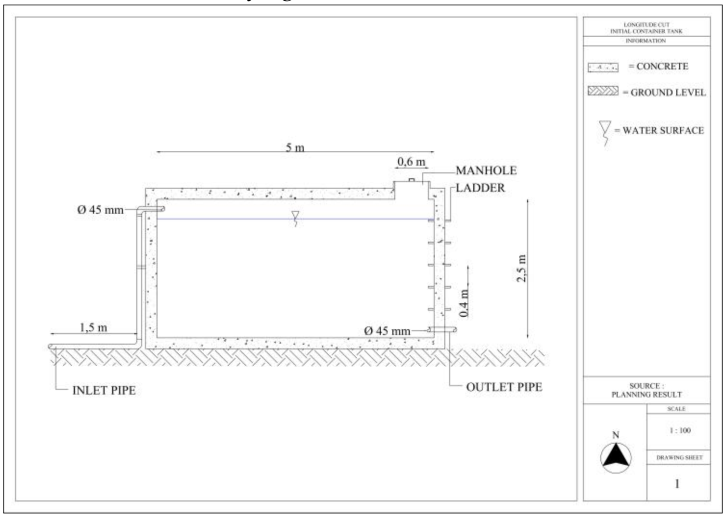

Figure 4. Longitudinal section of storage tank unit

2. Slow sand filtration unit

The slow sand filtration (SSF) units are designed with two parallel filtration units according to the design criteria in SNI 3981: 2008 to ensure operational reliability and continuity during maintenance. The filter media consists of 3 mm silica sand on top of a 200 mm gravel layer. The silica sand is the main filtration medium and the gravel layer provides structural support, prevents media migration, and promotes uniform hydraulic distribution. This arrangement allows for simultaneous physical straining, adsorption, and biodegradation on the upper surface of the sand bed, which results in the effective removal of suspended solids, pathogens, and biodegradable organic matter with relatively low energy input (Chen et al., 2021). Recent studies have shown that the upper layer of a slow sand filter plays the primary role in contaminant removal by synergistic interaction between microbial and the porous filter media leading to improved drinking water quality and better operational stability of the filtration process (Freitas et al., 2022). In the proposed system, the raw water is supplied to the filtration unit through the inlet pipe, is distributed uniformly by the overflow channel, percolates downward through the filter media, and is collected by the underdrain system of lateral and manifold pipes. The filtered water is then pumped to the next treatment unit in a continuous flow without changing the hydraulic loading conditions from the recommended design range. The detailed design criteria and calculation results are summarized in **Table 9**, and the detailed engineering design (DED) and longitudinal section of the filtration unit are presented in **Figure 5**.

Table 9. Design criteria and dimensions of the slow sand filter unit

Type	Calculate	unit	Design Criteria	Desc	Type	Calculate	unit	Design Criteria	Desc
Unit dimension					Number of bed filter				
Length	6	m	2:1 / 1:1	✓	Bed Filter	2	unit	2	✓
Width	3	m		✓	Piping system				
Height	3	m	2.5	✓	Inlet	50	mm	-	✓
Media filter					Outlet	355	mm	-	✓
Silika Sand	1	m	0.6-1	✓	Manifold	355	mm	-	✓
Gravel	0.3	m	0.15-0.30	✓	Lateral	110	mm	-	✓
Spillage					Head loss				
Gutter	6x0.75x0.7	m	-	✓	Underdrain	0.028	m	-	✓
					Media Filter	0.000022	m	-	✓
					Total	0.028	m	-	✓

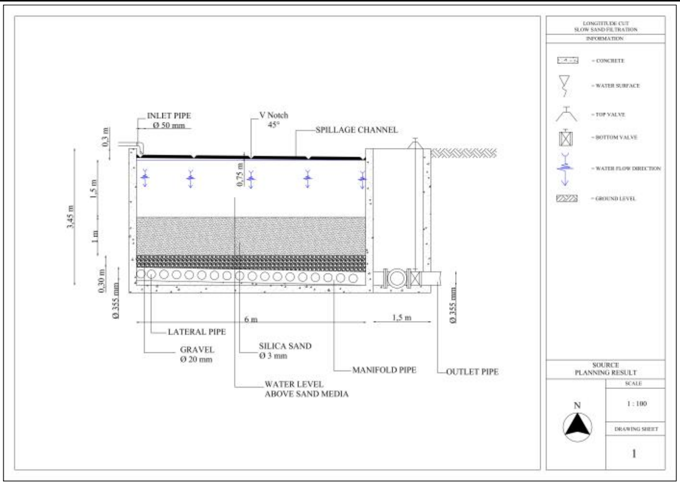

Figure 5. Longitudinal section of the slow sand filter showing media, underdrain, and overflow

3. Disinfection unit

The disinfection unit is designed to inactivate pathogenic microorganisms that may remain after the filtration process, thereby ensuring that the treated water complies with microbiological drinking water quality standards (Ren et al., 2022). In this design, two parallel disinfection units are provided to enhance operational reliability and facilitate maintenance, with chlorine applied as the disinfectant at an optimum dose of 3 mg/L (breakpoint chlorination/BPC) (Atiqotuzzummah & Rahman, 2025). This dosage was selected as it is able to sustain an acceptable free chlorine residual after fulfilling the chlorine demand of the treated water, thus providing continuous protection against microbial regrowth during storage and distribution and minimizing the risk of under disinfection. The effectiveness of chlorination has recently been shown to depend not only on the dose applied but also on the adequate mixing conditions, contact time and residual chlorine concentration, which together determine the efficiency of inactivation of bacteria, viruses and other waterborne pathogens (Ren et al., 2022 and Behera & Das, 2023). The design criteria are based on Ministry of Public Works (2007). The calculation results are shown in **Table 10**. The detailed engineering design (DED) of the disinfection unit is presented in **Figure 6**. Chlorine was selected because it is available at the study site and can be applied economically in small scale drinking water treatment systems. Disinfection is performed by injecting the chlorine simultaneously with the entering water through the inlet pipe. The hydraulic turbulence generated by the incoming flow favors a rapid and uniform mixing of the water with the disinfectant improving the efficiency of the chlorine utilization and providing a more uniform disinfection performance throughout the contact chamber.

Table 10. Design criteria and dimensions of the disinfection unit

Type	Cal	Unit	Design criteria	Desc
Number of unit				
Disinfection tank	2	unit	1	✓
Disinfectant				
Type	Chlorin (Cl_2)	-	Cl_2/ CaU Cl_2/ NaO Cl	✓
Dose	2.3	mg/L	2.50	✓
Dose/day	0.80	kg	-	✓
BPC	3	mg/L	3-5	✓
Chlorine tank				
Tank	300	L	-	✓

Type	Cal	Unit	Design criteria	Desc
Piping system (diameters)				
Injection	20	mm	-	✓
Inlet	355	mm	-	✓
Outlet	50	mm	-	✓
head loss				
Total	0.00039	m	-	✓

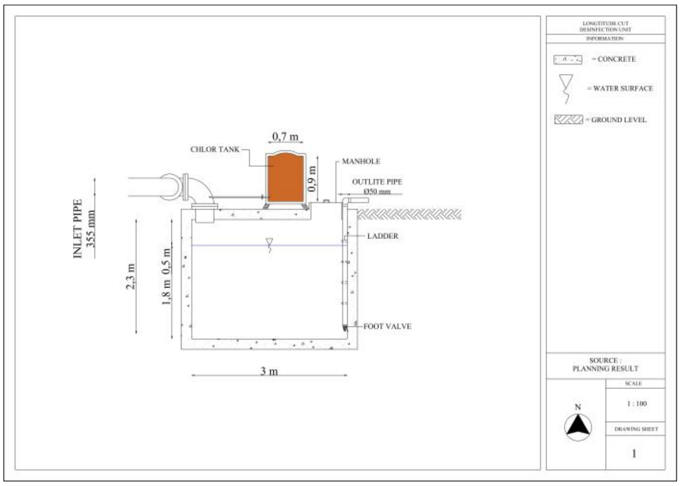

Figure 6. Longitudinal Section of disinfectant tank

4. Existing reservoir unit

In this plan, the reservoir used is an existing reservoir that has been constructed by the PAMSIMAS 2024 team. The existing reservoir is reused because it still has the capacity to hold the amount of water produced by the drinking water treatment unit. The existing reservoir specifications are listed in **Table 11**.

Table 11. Specifications of the existing reservoir of PAMSIMAS

Type	Cal	Unit
	Dimension	
Length	4	m
Width	4	m
Height	2.60	m
Tower Height	14.60	m
	Capacity	
Volume	416	m3

5. Layout of drinking water unit production

The layout in this plan is designed to facilitate viewing the entire configuration of the drinking water treatment unit at the PAMSIMAS drinking water production unit. **Figure 7** shows the layout of the PAMSIMAS drinking water production unit. Raw water is pumped from the Borehole to the storage tank for initial storage. Next, the water is channeled through a slow sand filtration unit, then enters a disinfection unit to remove pathogenic microorganisms. After going through this process, the water is channeled to a reservoir as a final storage place before being distributed to the service area.

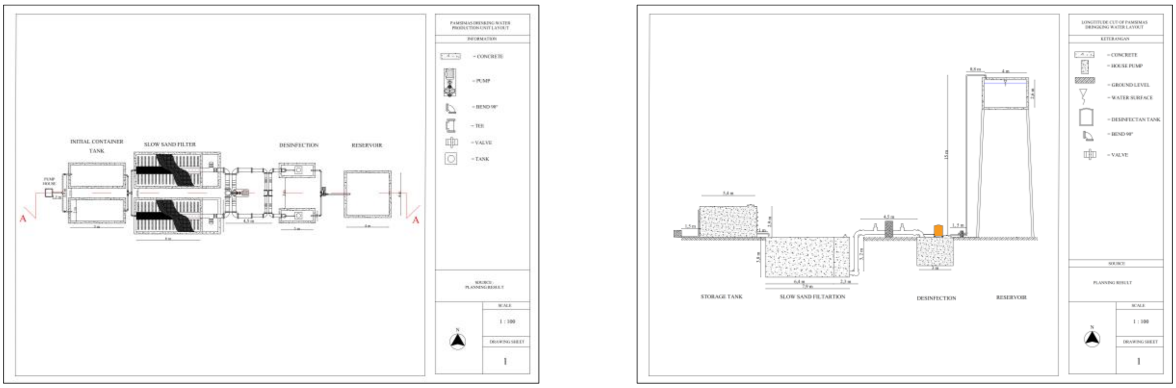

Figure 7. Layout of the production unit showing the flow path from borehole to reservoir

Routine maintenance activities for the unit include scraping the surface layer of the sand media when pressure loss (head loss) increases, periodically adding sand media, dosing chlorine and monitoring residual chlorine levels daily, and periodically inspecting the tank condition. All these activities of operation and maintenance can be performed without the need for operators specialized in the water treatment sector, and thus it is suitable for systems managed by the drinking water supply and sanitation system management group. However, the system's operational and maintenance activities are very dependent on having adequate funding to ensure the sustainability of its performance. Therefore, the determination of adequate household service tariffs needs to be done explicitly to ensure that maintenance costs can be met. The long-term success of the PAMSIMAS unit is more determined by the continuity of maintenance activities than the quality of initial construction.

3.6 Bill of Quantity (BOQ) and Cost Estimate

The BOQ is determined based on the technical specifications used in the treatment unit. The technical specifications can be seen in the DED that has been prepared.

To calculate the BOQ to be used, it is necessary to find the unit price of the work, which can be calculated based on the unit price analysisin accordance with the Directorate General of Construction Development (AHSP, 2024) and then calculated using the basic unit price data refers to Department of Highways and Construction Lampung Province (HSPK, 2023). The results of the BOQ and cost calculations can be seen in **Table 12**, with a total planned budget for the PAMSIMAS drinking water production unit amounting to IDR 1,110,048,239.

Table12. Bill of Quantity and Cost Estimate of the Kamplas Village PAMSIMAS drinking water production unit

Num	Type	Vol	Unit	Unit price	Price
			Storage Tank		
1	Multi-Stage Pump (3,907 KW)	1	Unit	IDR 40,000,000	IDR 40,000,000
2	PVC pipe	110	m	IDR 42,309	IDR 4,653,990
3	Pipe accessories	13	Pcs	-	IDR 3,498,400
4	Concrete	25	m^3	IDR 2,018,067	IDR 50,451,675
5	Land clearing	781	m^2	IDR 8,252	IDR 5,710,661
6	Manhole	0.0375	m^3	IDR 2,018,067	IDR 75,718
7	Pipe installation	110	m	IDR 93,099	IDR 10,240,934
8	Concrete reinforcement	3320	kg	IDR 17,667	IDR 58,655,317
9	Fine plasters	40	m^2	IDR 67,714	IDR 2,708,561
			Slow Sand Filtration		
1	Centrifugal Pump (0,1009 KW)	1	Unit	IDR 10,800,000	IDR10,800,000
2	PVC pipe	80	m	-	IDR 39,679,545
3	Silica sand	72	L	IDR 5,000	IDR 360,000,000
4	Gravel	10.8	L	IDR 3,500	IDR 37,800,000
5	Pipe accessories	28	Unit	-	IDR 67,233,700
6	Concrete	42	m^3	IDR 2,018,067	IDR 84,758,814
7	Concrete reinforcement	5577	kg	IDR 17,667	IDR 98,540,933
8	Pipe installation	80	m	IDR 93,099	IDR 7,447,952
9	Excavation	101	m^3	IDR 14,206	IDR 1,434,817
10	Iron plate	4.5	m^2	IDR 281,000	IDR 1,264,500
11	Fine plasters	93.6	m^2	IDR 67,714	IDR 6,338,033
			Disinfection Tank		
1	Concrete reinforcement	1593	Kg	IDR 17,667	IDR 28,154,552
2	Pipe installation	31	m	IDR 93,099	IDR 2,886,081
3	Excavation	13	m^3	IDR 14,206	IDR 184,679
4	Concrete	12	m^3	IDR 2,018,067	IDR 24,216,804
5	Pipe accessories	20	Pcs	-	IDR16,586,300
6	PVC pipe	31	m	-	IDR 8,334,247
7	Centrifugal Pump (0.21 KW)	1	Unit	IDR 14,900,000	IDR 14,900,000
8	Chlorine	50	Kg	IDR 40,000	IDR 2,000,000
9	Fine plasters	12	m^2	IDR 67,714	IDR 812,568
10	Manhole	0.037	m^3	IDR 2,018,067	IDR 75,718
		Total			IDR 991,114,499
		TAX 12%			IDR 118,933,740
		Grand Total			**IDR 1,110,048,239**

4. CONCLUSION

This study proposes a site specific, standard compliant, and fully costed design for a community scale drinking water production unit in Kamplas Village based on measured raw water quality and a stakeholder weighted selection from four candidate configurations. The design of the PAMSIMAS Drinking Water Production Unit in Kamplas Village uses the selected configuration (storage tank, slow sand filtration, disinfection and existing reservoir) with a design flow rate of 2.81 × 10-3 m^3/s for 1,558 people until 2028. The operation is without coagulant and within the technical and financial capacity of the PAMSIMAS so that the PAMSIMAS unit is sustainable and safe drinking water is continuously available in Kamplas Village. One filter train should be brought on-line and monitored before full operation. Monitoring should include turbidity, color, Fe, Mn, residual chlorine, and total coliform during the first year, actual filter run length compared with the design assumption and the PAMSIMAS tariff reviewed against realised O&M cost. The units response to seasonal variation in groundwater quality merits further study. Based on the bill of quantity (BOQ) and cost estimate, the total cost of the PAMSIMAS drinking water production unit is IDR 1,110,048,239

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