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Analysis of Existing Area, Clean Water Treatment, and Distribution Network Evaluation in Nagari Magek, Agam Regency, West Sumatra

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ABSTRACT

Nagari Magek Village in Agam Regency, West Sumatra, faces significant challenges in managing clean water resources. To address these challenges comprehensively, a holistic approach is essential, involving through area analysis, water treatment, and evaluation of distribution networks to ensure efficient and equitable water distribution. It is crucial to adhere to the principles of water resource conservation, utilization, and management as stipulated in Law Number 17 of 2019 on water resource management, which must be observed to ensure legal clarity in water management practices. The community service team handles clean water problems in Nagari Magek by designing a clean water treatment system that includes aeration, sedimentation, and filtration units. This process improves water quality by reducing yellowish color and eliminating unpleasant odors. However, the capacity of the treatment plant is not able to meet the increasing water demand, while the galvanized pipe distribution network has not been functioning optimally. Based on simulations using EPANET 2.2 software, it was found that the water flow speed in the pipes was still below the optimal range due to the diameter of the pipes being too large. The solution applied was to increase the processing discharge to 10 L/s (0,01 m3/s), which succeeded in increasing the flow rate according to the regulatory criteria. This recommendation improves the efficiency of the distribution system and ensures better water quality for the people in Nagari Magek.

Keyword: Clean Water, Water Treatment System, Distribution Network, EPANET, Nagari Magek

1. Introduction

The era of Sustainable Development Goals (SDGs) continues the journey of the Millennium Development Goals (MDGs), with the universal aim of maintaining balance across dimensions of sustainable development. One of the 17 agreed global goals is to ensure the availability of clean water and sustainable sanitation, a goal that is particularly relevant to Nagari Magek Village in Agam Regency, West Sumatra. Nagari Magek is one of the areas in Agam Regency facing challenges in managing clean water and sanitation.

The main issue faced by the community in Nagari Magek is the problem of turbid, yellow, foul-smelling water. In Sidang Surau Kasiak, water tanks are provided for each hamlet and function as public hydrants. This water service operates through a piping system that communally distributes water from the tower. The water supplied to the homes in Nagari Magek, especially in Sidang Surau Kasiak, contains metals such as iron (Fe), manganese (Mn), and sulfur (S). The water problems in this area stem not only from the absence of water treatment technology but also from a lack of skilled human resources to manage the system.

To maintain the quality of water and sanitation in Nagari Magek, a holistic approach is needed that includes an analysis of the existing area, clean water treatment, and an evaluation of the distribution network. Analyzing the existing area is the initial step to understand the challenges and potential of the water resources in the village. Clean water treatment is crucial to ensure that the available water meets the quality standards required for daily use. Evaluating the distribution network is necessary to ensure efficient and equitable distribution of clean water throughout Nagari Magek. Issues such as population growth and demands for better water quality complicate efforts to maintain clean water availability. Implementing water resource conservation, utilization, and damage control, as regulated in Law No. 17 of 2019 on Water Resources, is essential to create legal clarity and certainty in managing water resources in the village [1].

In the context of water and sanitation management, involving the community of Nagari Magek in preventive efforts, environmental improvement, and providing new models is key to success. A community-based approach that involves cooperation with local stakeholders, organization, and preventive measures is the right strategy to achieve SDG targets related to clean water and sanitation in this area. By integrating existing area analysis, clean water treatment, and distribution network evaluation into sustainable development efforts in Nagari Magek, it is hoped to maintain the availability of clean water and sustainable sanitation for all.

The goal of this community service is to analyze the existing conditions of water resources and sanitation in Nagari Magek and evaluate the clean water distribution network to ensure efficiency and equity in distribution. The expected benefits include improving the quality of clean water and sanitation, positively impacting public health, providing recommendations for improving the distribution network, and increasing community awareness and participation in managing clean water and sanitation. This service also supports the achievement of SDG goal 6 related to the availability of clean water and sustainable sanitation.

2. Method

2.1 Analysis of Existing Area

This step is to conduct direct observations to the site to identify the physical condition of existing water infrastructure, such as drilled wells, water towers, and distribution pipelines. Observation also includes observation of the quality from the water distributed, such as turbidity, color, and odor. Additionally, it is essential to document any visible signs of degradation or damage to the infrastructure that could affect water quality. This data will provide a baseline for further analysis and help identify specific areas that require improvement or maintenance.

2.2 Distribution Network

The step of distribution network is modeling and simulation using software, namely EPANET 2.2 to model the water distribution network based on the collected data. This modeling helps in analyzing water flow, pressure in pipes, and other potential problems that may not be directly visible. Additionally, EPANET 2.2 allows for the simulation of different operational scenarios to evaluate the impact of potential modifications or improvements. The insights gained from these simulations can guide decision-making and optimize the performance of the water distribution system.

2.3 Water Treatment System Design

In this method, the initial stage is to identify the water source to be used, after which the water quality analysis from the water source is carried out as a reference in determining the water treatment system to be applied. In this case, the water treatment process used is an aeration, sedimentation, and filtration unit. Aeration aims to increase oxygen levels and remove unwanted gases, while sedimentation allows large particles to settle before the water goes through a filtration process to remove fine particles and contaminants. Periodic evaluation of the performance of this treatment unit is important to ensure effectiveness and maintain optimal water quality.

3. Result and Discussion

3.1. Analysis of Existing Area

The main issue currently faced by the community in Nagari Magek is the problem of turbid, yellow, and foul-smelling water. One of the areas experiencing this water problem is Sidang Surau Kasiak. Sidang Surau Kasiak connects the Jorong Kasiak, Sawah Ladang, and Kubang. This area has a borehole well integrated with a solar power generation system, with a water capacity of 1.5 L/s (0,0015 m^3/s). The water source is stored in a 5 m^3 water tower and distributed through a network of pipes to water tanks in each jorong, serving as communal hydrants for the community. The water tower of Sidang Surau Kasiak is located behind Al-Jihad Mosque, approximately 442 meters from the Jorong Kasiak Office, with an elevation of 884 meters, an 8-meter-high support structure, and a 2-meter-high tank supplied by an inlet pipe 10.6 meters AGL. However, this water facility, built in 2020, has not been optimally utilized due to the poor quality of the distributed water.

Based on preliminary tests, the water supplied to homes in Nagari Magek, particularly in Sidang Surau Kasiak, contains metals such as iron (Fe), manganese (Mn), and sulfur (S). The presence of iron and manganese in the water is likely due to the soil and rocks through which the groundwater passes, while sulfur content may originate from sulfur sources around the groundwater area. Additionally, the primary occupation of the community as farmers may contribute agricultural waste that could lead to water contamination.

In Sidang Surau Kasiak, water tanks are provided for each jorong, functioning as public hydrants. This water service operates through a piping system that distributes water communally from the tower. Four water tanks are available to facilitate clean water for the community, located along the main road connecting the three jorongs in Sidang Surau Kasiak: Jorong Kasiak, Jorong Sawah Ladang, and Jorong Kubang. The iron content in the water causes problems in the water pipes, such as scaling and corrosion, which can shorten the lifespan of the pipes. Based on discussions with the Wali Nagari Magek, the water problems in this area stem not only from the absence of water treatment technology but also from a lack of skilled human resources to manage and maintain the water treatment system. Additionally, a lack of community awareness about the importance of safe drinking water treatment often hinders program implementation in Nagari Magek.

In addition to the main activities carried out during the service project, the team also mapped the clean water distribution in the area. This aims to help Nagari Magek, especially Sidang Surau Kasiak, understand the existing conditions of the clean water piping system. The team collected primary data as a reference for this mapping, starting with the elevation of the pipe channels, the height of inlet and outlet pipes, the number of households currently present, and other relevant data. The team also conducted analysis and provided recommendations for the piping system. This mapping included an analysis of domestic water needs, simulated using EPANET software.

3.2. Distribution Network

Based on the Indonesian National Standard (SNI 19-6728.1-2002) and the Directorate General of Human Settlements, Ministry of Public Works (2000), Nagari Magek, specifically Jorong Kasiak, Jorong Sawah Ladang, and Jorong Kubang, fall into the rural category. The coefficient for clean water usage for a Service Connection (SR) unit is 100 liters per person per day, with non-domestic unit coefficients at 20-30% and water loss coefficients at 20-30% [3, 4].

a. Domestic water demand
 = population served × water requirement per person
 = 675 people × 100 liters/person/day
 = 67,500 liters/day
 = 0.781 L/s (0,000781 m^3/s)
b. Non-domestic water demand
 = 30% × domestic water demand
 = 30% × 0.781 liters/second
 = 0.234 L/s (0,000234 m^3/s)
c. Total water demand
 = domestic water demand + non-domestic water demand
 = 0.781 liters/second + 0.234 liters/second
 = 1.016 L/s (0,001016 m^3/s)
d. Water loss
 = 20% × total water demand
 = 20% × 1.016 liters/second
 = 0.203 L/s (0,000203 m^3/s)
e. Average water demand
 = total water demand + water loss
 = 1.016 liters/second + 0.203 liters/second
 = 1.219 L/s (0,001219 m^3/s)
f. Maximum water demand
 = maximum day factor × average water demand
 = 1.1 × 1.219 liters/second
 = 1.341 L/s (0,001341 m^3/s)
g. Peak hour water demand
 = peak hour factor × average water demand

= 1.5 × 1.219 liters/second
= 1.828 L/s (0,001828 m^3/s)

The calculated water demand for the Jorong Kasiak, Jorong Sawah Ladang, and Jorong Kubang areas is 1.828 liters/second (0,001828 m^3/s). Consequently, this water demand exceeds the treatment system's water discharge capacity, which is 1.5 liters/second (0,0015 m^3/s).

3.2.1 Distribution Network Evaluation

Based on the existing conditions behind the Al-Jihad Mosque, the water tower, which serves as the reservoir, already has a distribution network extending to Jorong Kasiak, Sawah Ladang, and Kubang. The distribution network utilizes galvanized pipes, with the primary pipe measuring 4 inches (100 mm)and the secondary pipes measuring 2.5 inches (65 mm). These pipes are installed to deliver water to tanks available in each jorong. However, this distribution network is not functioning well, and in some areas, water is not yet distributed. The Al-Jihad Mosque has a reservoir with a capacity of 5 m^3 located at an elevation of 892 meters above sea level (ASL), and the receiving areas are situated at elevations between 860 and 868.1 meters ASL. Therefore, a branched distribution system model with gravity flow type is employed.

The water distribution network in Sidang Surau Kasiak is designed considering the study area's situation and conditions, following the existing network layout in the field using EPANET 2.2 software. This program allows the analysis of water flow, pressure, and chemical concentrations in the pipes over the distribution period, aiming to understand the movement and fate of drinking water within the distribution network. The piping network, as a series of hydraulically connected pipes, enables the spread of influence from flow rate changes in one pipe to other pipes, detectable through pressure changes in the pipes.

EPANET 2.2 is a computer program that simulates the hydraulic and water quality behavior within a pipe network. The network consists of pipes, nodes (pipe connection points), pumps, valves, and water tanks or reservoirs. EPANET 2.2 explores the water flow in each pipe, the water pressure conditions at each point, and the concentration of chemicals flowing within the pipes over the distribution period. EPANET 2.2 is designed as a tool to achieve and realize an understanding of the movement and fate of drinking water content in the distribution network. EPANET 2.2 can also be used to analyze design creation, hydraulic model calibration, chlorine residual analysis, and customer analysis. EPANET 2.2 assists in strategizing to realize water quality in a system [6].

Below is the distribution network map depicting the position of the distribution pipes and the flow direction that has been installed (green), and junctions (blue points) which are the pipe junctions and points where water will enter and exit the piping network (Figure 4).

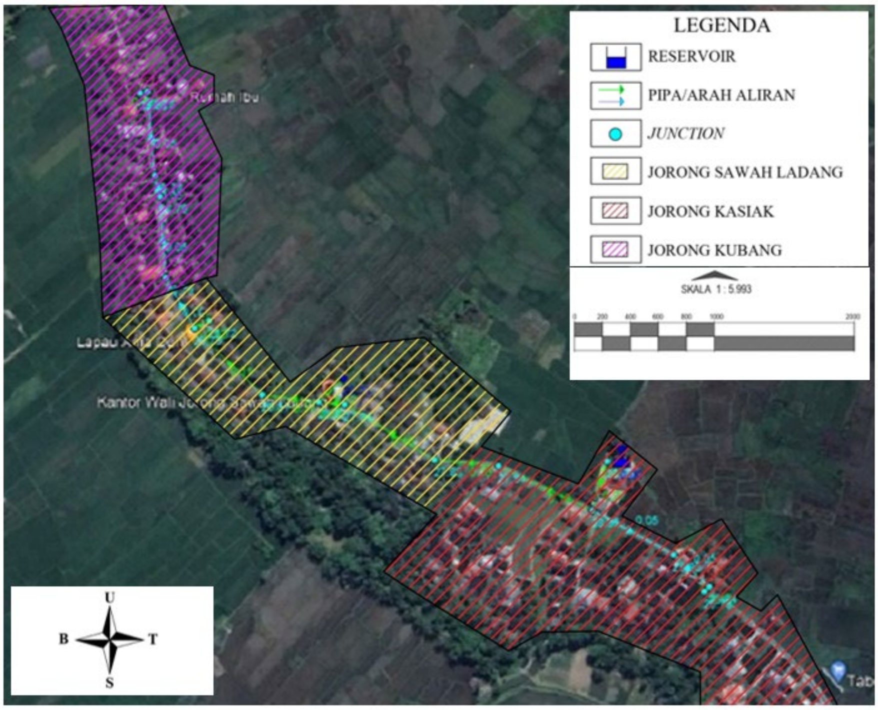

Figure 4. Distribution Network Map

The pipes of network is a series of hydraulically connected pipes, such that a change in flow rate in one pipe will affect other pipes. These changes can be detected by observing the pressure variations in the pipes, which is essential for maintaining the system's efficiency and stability [7]. In EPANET 2.2 operation, input data is required for simulating the clean water distribution network to obtain the desired output. This data includes various parameters that help in accurately modeling the behavior of the distribution system under different conditions. **Table 1** presents the node parameter data for the water distribution network in Jorong Kasiak, Sawah Ladang, and Kubang. Node parameters are created based on guidelines that include each pipe branch, parameter changes, and the presence of tappings. These parameters include elevation, base demand, demand, and pressure at each junction. Accurate node parameters are crucial for effective network simulation, as they help in identifying potential issues such as pressure drops or flow inconsistencies.

A junction is a point in the distribution system representing the connection of two or more pipes (usually connected with fittings), with elevation being the most crucial component in a junction. Elevation depicts the height of a location relative to its surroundings (above sea level) and is a critical factor in distribution network modeling because it significantly affects the Hydraulic Grade Line (HGL) or hydraulic gradient value in the model [8]. Elevation is used to calculate the pressure at the junction, which is vital for ensuring that the water supply meets the required standards across the network [9]. Next, the base demand represents the average or nominal water demand. A negative value in the base demand indicates the presence of an external source entering the junction, which can affect the overall system dynamics. If this table is empty, the demand is assumed to be zero, implying that there is no significant water usage at that particular junction. This data is instrumental in designing and maintaining a reliable and efficient water distribution system, ensuring that all areas receive an adequate and consistent water supply.

Table 1. Node Parameters of the Distribution Network in Jorong Kasiak, Sawah Ladang, and Kubang

	Elevation	Base Demand	Demand	Pressure
Node ID	m	LPS	LPS	M
Junction 2	863	0	0.00	28.99
Junction 3	863	0	0.00	28.95
Junction 4	863	0	0.00	28.95
Junction 5	863	0	0.00	28.94
Junction 6	866.16	0.457	0.46	25.78
Junction 7	864	0	0.00	27.91
Junction 8	864	0	0.00	27.88
Junction 9	864	0	0.00	27.84
Junction 10	863	0	0.00	28.82
Junction 11	868.1	0.457	0.46	23.71
Junction 12	865	0	0.00	26.81
Junction 13	862	0	0.00	29.79
Junction 14	866.07	0.457	0.46	25.72
Junction 15	863	0	0.00	28.79
Junction 16	863	0	0.00	28.79
Junction 17	863	0	0.00	28.78
Junction 18	863	0	0.00	28.78
Junction 19	866.1	0.457	0.46	25.68
Reservoir	892	#N/A	-1.83	0.00

This table provides an overview of the elevation, base demand, demand, and pressure at various junctions within the water distribution network in the specified areas. Elevation is measured in meters above sea level, base demand and demand are in liters per second (L/s), and pressure is in meters (m). These parameters are crucial for analyzing hydraulic performance and ensuring efficient water distribution. Understanding elevation, demand, and pressure helps identify potential issues and optimize the system for better performance. Accurate analysis of these parameters is essential for designing a network that can handle varying demands and maintain adequate pressure. Elevation differences impact pressure levels, requiring careful calibration. Base demand helps predict future needs and plan for capacity expansions.

The following table (Table 2) presents line parameter data, including pipe diameter, roughness coefficient, flow, and velocity. Pipe diameter affects flow rate and velocity, while the roughness coefficient impacts friction losses. Flow indicates the water volume passing through the network, and velocity shows the speed of water movement.

Table 2. Line Parameters of the Distribution Network in Jorong Kasiak, Sawah Ladang, and Kubang

	Diameter	Roughness	Flow	Velocity
Link ID	mm		LPS	m/s
Pipe 1	100	120	1.83	0.21
Pipe 2	100	120	1.83	0.21
Pipe 3	100	120	0.46	0.05
Pipe 4	100	120	0.46	0.05
Pipe 5	65	120	0.46	0.12
Pipe 6	100	120	1.37	0.16
Pipe 7	100	120	1.37	0.16
Pipe 8	100	120	1.37	0.16
Pipe 9	100	120	1.37	0.16
Pipe 10	65	120	0.46	0.12
Pipe 11	100	120	0.91	0.11
Pipe 12	100	120	0.91	0.11
Pipe 13	65	120	0.46	0.12
Pipe 14	100	120	0.46	0.05
Pipe 15	100	120	0.46	0.05
Pipe 16	100	120	0.46	0.05
Pipe 17	100	120	0.46	0.05
Pipe 18	65	120	0.46	0.12

This table presents the line parameters of the water distribution network in Jorong Kasiak, Sawah Ladang, and Kubang. The diameter is measured in millimeters (mm), the roughness coefficient indicates the roughness of the pipe's internal surface, flow is measured in liters per second (L/s), and velocity is measured in meters per second (m/s).

Based on the simulation results of the distribution network using EPANET 2.2 software, it has been calculated that the node parameters meet the minimum pressure requirements (0.5-1 m) according to Ministerial Regulation No. 27 of 2016 on the implementation of the drinking water supply system [10]. However, for the link parameters, the simulation results show that the velocity values are still below the criteria. Where the flow velocity in the pipe as specified is 0.3-0.6 m/s.

This situation arises because the installed pipe diameter is too large to efficiently handle a very small flow rate of 1.5 L/s (0,0015 m^3/s). To address this issue, there are two recommended options. The first option is to increase the treatment flow rate, while the second option involves replacing the distribution pipe with a smaller diameter. However, opting for the second choice poses significant challenges and costs due to the need to dismantle the existing pipes. Therefore, a simulation will be conducted using EPANET 2.2 software, focusing on the first option of increasing the treatment flow rate. This simulation aims to optimize the system's performance and ensure it meets operational requirements effectively.

3.2.2 Distribution Network Recommendation

EPANET 2.2 can aid in strategizing to achieve optimal water quality within a system. Consequently, the team recommends enhancements to the distribution network based on simulation outcomes. This includes substituting current distribution pipes with high-density polyethylene (HDPE) pipes, utilizing 2.5 inches (65 mm) for primary pipes and 2 inches (50 mm) for secondary pipes. The selection of HDPE pipes is based on several advantages, including:

1. Longevity (50-100 years) under normal conditions (temperature of 20°C).
2. Flexibility for bending.
3. Roughness equivalent to 1/8 of iron pipes.
4. Corrosion-free and resistant to chemical solutions.
5. Affordable pricing.

Below are the recommended clean water network configurations, which have been meticulously simulated and optimized using the advanced capabilities of EPANET 2.2 software (refer to Table 3 and Table 4). These configurations are the result of rigorous analysis and modeling, aimed at enhancing the efficiency and reliability of the water distribution system. By leveraging EPANET's powerful simulation capabilities, the team has proposed specific improvements tailored to address flow rate optimization, pressure management, and overall system resilience.

Table 3. Node Parameters of the Distribution Network after Increasing Treatment Flow Rate

	Elevation	Base Demand	Demand	Pressure
Node ID	M	LPS	LPS	m
Junction 2	863	0	0.00	28.69
Junction 3	863	0	0.00	27.59
Junction 4	863	0	0.00	27.43
Junction 5	863	0	0.00	27.35
Junction 6	866.16	2.5	2.50	24.11
Junction 7	864	0	0.00	25.28
Junction 8	864	0	0.00	24.46
Junction 9	864	0	0.00	23.12
Junction 10	863	0	0.00	23.80
Junction 11	868.1	2.5	2.50	18.25
Junction 12	865	0	0.00	21.46
Junction 13	862	0	0.00	23.89
Junction 14	866.07	2.5	2.50	19.59
Junction 15	863	0	0.00	22.79
Junction 16	863	0	0.00	22.66
Junction 17	863	0	0.00	22.62
Junction 18	863	0	0.00	22.48
Junction 19	866.1	2.5	2.50	19.28
Reservoir	892	#N/A	-10.00	0.00

Table 4. Link Parameters of the Distribution Network after Increasing Treatment Flow Rate

	Diameter	Roughness	Flow	Velocity
Link ID	mm		LPS	m/s
Pipe 2	100	120	10.00	1.27
Pipe 5	65	120	2.50	0.75
Pipe 6	100	120	7.50	0.95
Pipe 7	100	120	7.50	0.95
Pipe 8	100	120	7.50	0.95
Pipe 9	100	120	7.50	0.95
Pipe 10	65	120	2.50	0.75
Pipe 11	100	120	5.00	0.64
Pipe 12	100	120	5.00	0.64
Pipe 13	65	120	2.50	0.75
Pipe 14	100	120	2.50	0.32
Pipe 15	100	120	2.50	0.32
Pipe 16	100	120	2.50	0.32
Pipe 17	100	120	2.50	0.32
Pipe 18	65	120	2.50	0.75
Pipe 1	100	120	10.00	1.27
Pipe 19	100	120	2.50	0.32
Pipe 21	100	120	2.50	0.32

The recommendation to increase the treatment flow rate resulted in changes to the final flow velocity in the simulated pipes. Based on the analysis using EPANET 2.2 software, when the treatment flow rate is increased to 10 L/s (0,01 m^3/s), the flow velocity meets the minimum pressure requirements stipulated in the regulation. The flow velocity ranges between 0.32 to 1.27 m/s, which meets the criteria of 0.3-0.6 m/s.

3.3 Clean Water Treatment System

The quality of clean water has a significant impact on public health and well-being, making the measurement of physical, chemical, and microbiological parameters a crucial step in this evaluation. The obtained data will be compared with applicable water quality standards, such as those stipulated in the Ministry of Health Regulation No. 2 of 2023 on environmental health [5]. This analysis aims to provide a comprehensive overview of the clean water quality in Nagari Magek and serve as a basis for recommendations for improvements and more effective water resource managementThe analysis of water quality in Nagari Magek, Agam Regency, West Sumatra, has revealed that color and odor are critical indicators of contamination, with distinctive yellow deposits suggesting the presence of dissolved metals and unpleasant odors potentially signaling unwanted microorganisms or chemicals. This underscores the importance of monitoring these parameters to ensure safe and high-quality water. In response, the community service team has developed a clean water treatment system incorporating aeration, sedimentation, and filtration units. Aeration involves adding air or oxygen to water using a cascade aerator, which is cost-effective and eliminates the need for pumps. Sedimentation utilizes gravitational force to allow heavier solids to settle at the bottom of the tank, though some lighter particles may still exit with the water. This multi-stage approach is designed to address contamination and improve water quality for the residents of Nagari Magek.

Therefore, filtration of the treated water is necessary. Water exiting the sedimentation outlet pipe will then enter the filtration tank. Filtration is a process that reduces water contamination by suspended particles through a porous medium (filter media) by trapping particles in the pore spaces, resulting in the collection and accumulation of these particles on the surface of the media grains. These three water treatment units are installed near the Sidang Kasiak water tower and arranged sequentially from the aeration unit (top tank), sedimentation unit (middle tank), to the filtration unit (bottom tank) (Figure 2). These tanks are connected by installing inlet and outlet pipes on each tank. The clean water distribution flow collected in the water tower will pass through this treatment unit first before being distributed. The quality of water that has passed through this treatment installation will undoubtedly be better compared to the water quality before treatment because water contaminants have been removed through the applied treatment processes.

Figure 2. Clean Water Treatment Installation in Sidang Kasiak

The following describes the water quality before and after undergoing the clean water treatment process that has been implemented. The clean water treatment installation designed and built in Sidang Surau Kasiak is tailored to the existing water quality. The treatment units constructed include aeration, sedimentation, and filtration units. Results indicate a reduction in the yellow coloration of the water to a clearer state and the elimination of unpleasant odors. This improvement is illustrated in **Figure 3** section (a) and (b).

(a) (b)

Figure 3. (a) Water Quality Before Treatment (b) Water Quality After Treatment

After undergoing the aeration process, which ensures optimal oxygenation, the sedimentation process, which allows suspended particles to settle efficiently, and the filtration process, which filters out particles, the treatment has gone through the necessary stages to achieve optimal quality. Although it has not yet been tested with equipment such as a Water Quality Meter for chemical parameters, it is physically evident that the operational treatment unit can remove contaminants from the water in the Sidang Kasiak water tower.

4. Conclusion

The community service team addressed the clean water issues in Nagari Magek by designing a clean water treatment system, which includes aeration, sedimentation, and filtration units. After undergoing the aeration process to ensure optimal oxygenation, sedimentation process enabling efficient settling of suspended particles, and filtration to remove particles, the treatment has undergone necessary stages to achieve optimal quality. This process resulted in improved water quality by reducing yellowish coloration and eliminating unpleasant odors. However, the water demand in the area exceeds the treatment plant's capacity. Although a galvanized pipe distribution network has been installed, it is not yet functioning optimally, and some areas remain undistributed.

Based on the EPANET 2.2 software simulation of the water distribution network in Jorong Kasiak, Sawah Ladang, and Kubang, it was found that while node parameters met the minimum pressure requirements specified by Ministerial Regulation No. 27 of 2016 on the implementation of the drinking water supply system (0.5-1 m), flow velocities in the pipes remained below the optimal range of 0.3-6 m/s. This inefficiency was attributed to the oversized diameter of the installed pipes, which struggled to handle the low flow rate of 1.5 L/s (0,0015 m^3/s) effectively.

To address this issue, two solutions were considered: increasing the treatment flow rate and replacing the pipes with smaller diameters. The latter option was deemed costly and technically challenging due to the need for infrastructure dismantling. Therefore, a simulation was conducted to assess the impact of increasing the treatment flow rate. This adjustment proved successful; increasing the flow rate to 10 L/s (0.01 m^3/s) resulted in flow velocities ranging from 0.32 to 1.27 m/s, meeting regulatory criteria and ensuring optimal system performance. The increase in the treatment flow rate not only improved flow velocities but also complied with the operational requirements outlined in Ministerial Regulation No. 27 of 2016 on the implementation of the drinking water supply system. This adjustment in the water distribution network enhances efficiency and ensures better water quality delivery to the community in Nagari Magek.

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