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Groundwater Quality Analysis for Domestic Needs in the Lampulo Coastal Region of Banda Aceh

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Abstract *Morphology Gampong Lampulo is a coastal region with alluvial plains. The groundwater potential on the alluvial plains is quite significant. Alluvial plains are formed by deposits of sand, mud, and grass carried by rivers and deposited for a long time. The research aims to analyze the quality of groundwater for domestic needs in the area of Lampulo City, Banda Aceh. To achieve this goal, a descriptive method and cross-sectional approach are used by measuring physical parameters (taste, color, smell), DHL, and pH directly in the field using a water checker device at 50 sampling points based on a grid of samplings to obtain representative information about a particular characteristic or variable in the broader area or region. This method involves the creation of a network or grid consisting of sampling points regularly scattered throughout the area to be studied. The results of the field survey were an analysis of the quality of fresh groundwater for domestic needs in some parts of the region of Lampulo based on several parameters, such as the physical parameters 80% clear, 100% odorless, and 80% non-sense (sensitive). In contrast, for the DHL parameters, 88% are freshwater, and the last is for the dominant pH parameters. 68% of groundwater reacts base because the soil water is affected by carbonates, bicarbonates, and hydroxides, resulting in groundwater loss in the study area. According to the results of interviews with the citizens of Lampulo, the ground is used only for household needs. The land altitude in the Lampulo region ranges from 1.42 to 6.78 meters, with a stream of land flowing from the south, an alluvial plain region, to the north, a coastal region.*

Keywords: *Water Quality; Land; Domestic Needs; Coastal Region*

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1. Introduction

Geographically, Indonesia's vast territory consists of water. However, the fact is that the water that can be used for everyday activities is still in a sufficient category in terms of quality and is still found in many areas of Indonesia suffering from a clean water crisis (Setioningrum et al., 2020). Water quality will affect the level of human health, as water is one of the means of spreading disease, both on and off shore (Prayitno, 2015).

Water quality is affected by natural and anthropogenic effects, including local climate, geology, and practical irrigation, so unwanted constituents enter the soil, making it difficult to control their dissolution (Ramesh & Elango, 2012). However, water quality in reservoirs is also governed by anthropogenic processes such as industrial, man-exploited agriculture, and natural processes including rainfall, precipitation, erosion, mineral deposits, and other geological phenomena (Saalidong et al., 2022).

Groundwater naturally contains mineral ions. Ions are slowly coming out of soil particles, sediments, and rocks as water flows along the surface of minerals in pores or cracks in unsaturated zones, and these aquifers are called soluble solids. Some soluble

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solids may have originated from rainwater or river water, which will replenish the aquifer (Harter, 2003).

Groundwater is a more reliable and widely used natural resource, accounting for about 20% of the world's freshwater supply, or 0.61% of all world water. This makes it a much-needed resource and can be stored naturally to be utilized during periods of water shortage (Alsalme et al., 2021). Airtanah becomes one of the good sources of water for drinking or for other clean water needs because of its various advantages over other water sources. Groundwater is an important component of the hydrological cycle (Afriyani et al., 2020). As the potential of groundwater varies in some places, so the problems that arise are not the same, overall it can be said that in each region there is a decrease in the reserves of groundwater resources as well as a decline in the quality of the groundwater (Widiyanto et al., 2015).

On the other hand, groundwater in coastal areas is very dynamic and is influenced by the distance from the sea, the depth of groundwater, the porosity of rocks, and human activity in them. Seasons will influence the dynamics, so the probability of occurrence in the rainy season of seawater intrusion is greater than in the rainy season. Seawater intrusion is the entry of seawater into a freshwater aquifer as a result of the pressure of seawater caused by the presence of empty holes in the aquifer. These factors resulted in a decline in groundwater quality (Febriarta, 2020).

Banda Aceh, as the capital of the province of Aceh, has indeed experienced rapid development in both directions, including the construction of cities and rapid population growth. construction means and facilities Forms of physical development of residential areas, transportation, construction businesses, offices, culinary tourism, industry, and households in Banda Aceh and its surroundings affected the accumulation of various dirt types in the urban environment, including air. In addition to the physical construction of the city contributing to the reduction of the amount of vegetation in the green zones, city parks, and other green areas that act as shadows, reducing noise, micro-air conditioning, carbon dioxide absorbed, and oxygen generators, caused the loss of open green space in the city of Banda Aceh (Afriyani et al., n.d.).

The geology of the region of Lampulo is an alluvial area, with the volume of groundwater in the alluvial plains being determined by the thickness, distribution, and permeability of the groundwater layer. If the groundwater surface around the alluvial plain is higher than the water surface, the groundwater potential is quite high (Penyusun et al., n.d., p. 41). If the groundwater surface is low, then it will acquire shallow well water.

Gampong Lampulo is one of the gampongs in the natural wall with a population of about 1,318 family cards, consisting of 4 Dusun, among them Dusun Teuku Tuan Dipulo, Dusun Malahayati, Dusan Teuku Teugoh, Geographically, the territory of Lampulo borders a few Gampongs, namely Lamdingin in the east, Gamong Gano in the north, Gammong Magnificent in the south, and Java Gumpong in the west (Almukarramah et al., 2022)

Based on this background, it can be assumed that the groundwater

potential in the region of Lampulo is very high and is shallow enough for everyday use. In connection with the hypothesis, the main objective of this study is to analyze the quality of groundwater for domestic needs so that the use of such water resources can take place optimally and does not cause environmental damage by groundwater pollution. Here's a map of the research area: Figure 1.

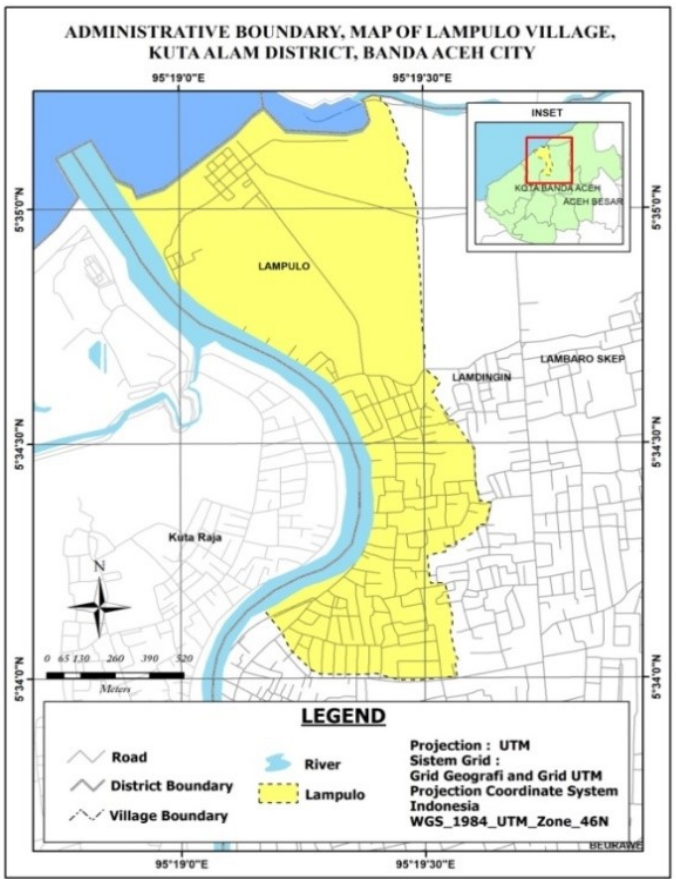

Figure 1. Map of Gampong Lampulo Administration

2. Methods

This research employs a descriptive research methodology with a cross-sectional approach. Physical parameters (odor, color, taste), Electrical Conductivity (EC), and pH were measured directly in the field using a water checker. The research and observations were conducted in June 2023, with sample collection taking place from morning to daytime under clear weather conditions in the Lampulo area. To determine the geographic location for groundwater sample collection, the Avenza Maps application was utilized. Groundwater samples were collected at 50 sampling points using a grid system, with one sample taken from each 100m x 100m grid, as depicted in Figure 2.

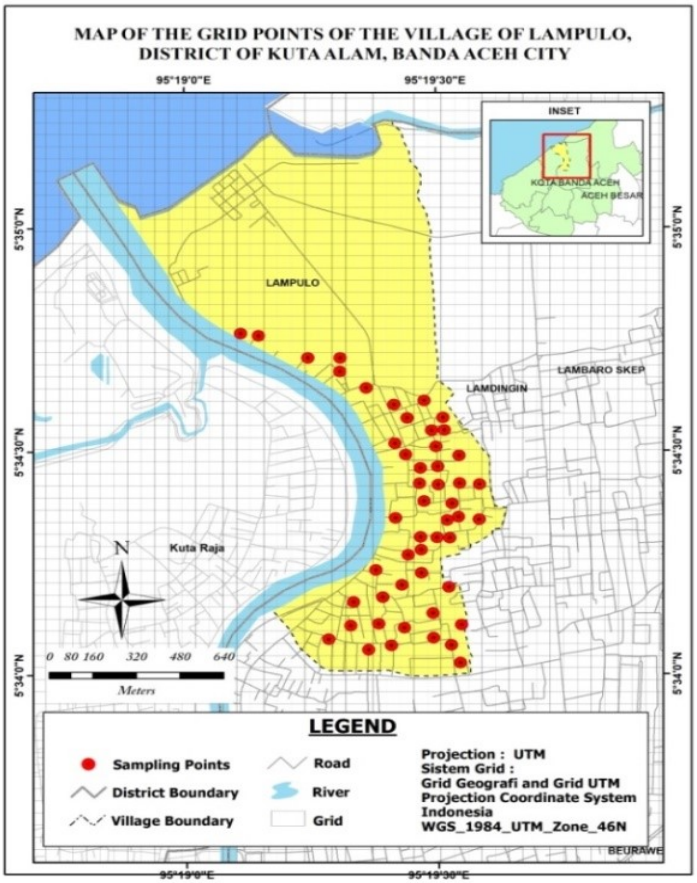

Figure 2. Lampulo Village Grid Point Map

The initial method of research was to collect data by determining the sampling point and coordinate point of the well using Avenza Maps, while for DHL measurements, the pH itself was measured using a water checker. The sampling point was done using a grid that was 50 m long and 50 m wide. Each of the grid boxes takes a random sample point of groundwater by considering the layout that could describe each grid. After finding the well point, the Avenza Maps app immediately finds the coordinate point of the well in the field. From the point of coordinates, it then operates using ArcGis to create DHL spread maps and maps of the direction of the water flow. The grid point map can be seen in Figure 2.

3. Results and Discussion

The results of the field survey of the quality of fresh soil water for domestic needs in some areas of Lampulo District of Kuta Nature have been taken from as many as 50 samples of well water. The data from observations and measurements of groundwater were then compiled into a groundwater comparison table for 50 wells belonging to the population, according to various physical parameters that were utilized, including:

Color

Water color changes are usually caused by other hazardous substances. Colored materials are created when water comes into contact with organic garbage such as leaves and wood,

which are processed in decomposition. The color may also be due to the presence of tannins and humic acids that combine with caporites to form toxic chloroform compounds that affect the health of water users.

Table 1. Water Quality Test Results Based on Color Physics Parameters

No	Category Color Groundwater	Number of wells	Percentage (%)
1	Clear (Colorless)	40	80
2	Slighty Yellow	4	8
3	Yellow	2	4
4	Reddish Yellow	0	0
5	Murky	4	8
Amount		**50**	**100**

Source: Research Results Lampulo, 2023

Based on the measurement of the physical parameters of color on 50 groundwater samples can be classified into five categories of groundwater color Table 1. The dominant category of clear or uncoloured groundwater samples is as many as 40 samples of about 80% of the total sample. Then followed by the category of water samples of a rather yellow color as 4 samples or 8%, then the category water sample of a yellow colour there are 2 samples, or 4% and the latter followed the category the sample water colour of a shrimp there are four samples about 8%, but in the coastal area of Lampulo there is no category of red yellow water. The cause of the colour (relatively yellow, yellow and crisp) in some wells is due to the presence of organic material and inorganic material, due to presence metal ions such as iron and manganes (Siti Munfiah, Nurjazuli, Onny Setiani, n.d.)

Smell

According to Effendi (2003), good and safe drinking water is water that doesn't smell, whether it's smelled from far away or near. The water smells unpleasant because of the organic content that microorganisms dissolve in it. The scent of water can indicate the quality of the water; for example, the smell of ammonia can be caused by algae in groundwater. In addition, the high iron content in water can also affect the physical quality of groundwater so that it can smell the iron smell that is visible in groundwater.

Some of the primary sources of odor are hydrogen sulfide and organic compounds generated by anaerobic decomposition. Apart from causing complaints, odor may also be an indicator of the presence of toxic gases or anaerobic conditions in units that can have adverse effects on health or the environment (Vanatta, 2000).

Table 2. Water Quality Test Results Based on Odor Physics Parameters

No	Category Smell Groundwater	Number of wells	Percentage (%)
1	Doesn't smell	50	100
2	Smell of lump	0	0
3	Metal smell	0	0
Amount		**50**	**100**

Source: Research Results Lampulo, 2023

Based on the results of the measurement of the physical parameter odor on 50 samples of groundwater, it can be classified into three categories of odor (Table 2). The dominant groundwater sample category is

odorless, with a total of 50 samples, or 100%, but in the coastal region of Lampulo, there is no category for mud smell or metal smell.

Flavor

The taste of the water is related to the nitrate content of the groundwater, i.e., the higher the nitrates in the water, the more it is affected by the level of taste within the water. In addition, it contains a high amount of iron, which can also affect the taste quality of the water by making it feel bitter. Physical parameters of flavor measurement using a condenser.

Table 3. Water Quality Test Results Based on Physical Taste Parameters

No	Goundwater flavor category	Number of wells	Percentage (%)
1	Tasteless	40	80
2	Brackish	8	16
3	Salty	1	2
4	Very Salty	1	2
Amount		**50**	**100**

Source: Research Results Lampulo, 2023

Based on the measurement of the physical parameters of the flavor in 50 samples of groundwater, it can be classified into four categories of flavors. Table 3. The general group was 40, or 80%, of freshwater samples, followed by 8 samples, or 16%, of saltwater, and the last group of salty and highly salty water, 1 sample, or 2%, respectively. Airtanah that feels payau can be caused by its location near the coast or sea, so that sea water enters the well (Permana, 2019). whereas asymmetry is caused by the presence of certain salts that are soluble in water (srikandi, n.d.).

Electric Conductivity

Electrical transmission power is a number to indicate the ability of a liquid solution to transmit electric current. The capacity depends on the presence of the ions, the total concentration of the ion, the valence of its relative concentration, and the temperature at which they are measured. The higher the conductivity of the water, the more salty it tastes. The higher the conductivity in water, the water will taste salty to brackish (Afriyani, 2020). Electrical transmission power is used as an indicator of water fertility (Ruseffandi & Gusman, n.d.). In other words, the power transmitter can provide information that a substance or pollutant is soluble in groundwater.

The measurement of Electrical Conductivity (EC) is carried out using a conductivity meter with units in µmhos/cm. The principle of this device is the calculation of the number of ions dissolved in the sample solution is directly proportional to the electrical conductivity. EC measurements are useful for: 1). Determining the level of mineralization and the degree of dissociation of distilled water. 2). Estimating the overall effect of ion concentrations. 3). Evaluating appropriate treatment for the mineral conditions of water. 4. Estimating the amount of dissolved solids in water. 5. Determining whether water is suitable for consumption or not (Effendi, 2003).

Table 4. Data of groundwater quality measurement results based on Electrical Conductivity parameters

No	DHL Category (µS/cm)	Number of wells	Percentage (%)
1	Fresh Groundwater (<1,200)	44	88
2	Brackish Groundwater (1,200 - 2,500)	6	12
3	Salty Groundwater (2,500 - 4,500)	0	0
4	Very Salty Groundwater (>4,500)	0	0
Amount		**50**	**100**

Source: Research Results Lampulo, 2023

Based on the measurement of DHL parameters in 50 samples of groundwater, they can be classified into four DHL categories. (Table 4). The freshwater category is dominated by a total of 44 samples of approximately 88%, followed by the water category of 6 samples of about 12%, although in the coastal area of Lampulo there is no salt water category and very salt water.

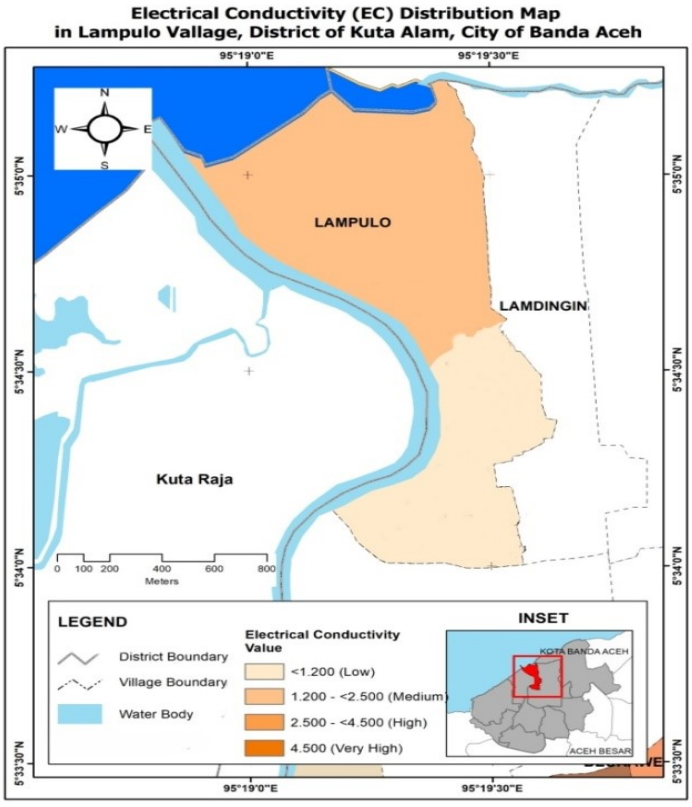

Figure 4. Map of the Spread of DHL Village of Lampulo

pH

According to Atima (2015), the known pH value itself is a pH value that can be used to determine whether the acidic-base properties of the water have changed its natural pH value; if the value is higher than usual, then the water becomes too basic, or if it is already lower, then the water will be too acidic. If that happens, it will reduce the value of water usage in addition to disrupting water life or ecosystems

(Hasanah & Said, 2020). The pH determines the acidity and alkalinity of fresh water (Dandge & Patil, 2022).

Table 5. Airtanah Quality Measurement Results Data PH Parameters

No	Groundwater PH category	Number of wells	Percentage (%)
1	Acid (<7)	8	16
2	Neutral (7)	8	16
3	Alkaline (>7)	34	68
Amount		**50**	**100**

Source: Primary Data, 2023

Based on measurements of pH parameters at 50 samples in the three categories of Table 5. The soil-water sample category dominated a base reaction of 34 samples, or 68%, the last of which was an acid reaction and a neutral reaction with 8 samples, or 16%, respectively. The presence of carbonates, bicarbonates, and hydroxides increases water content. At the same time, the presence of acids in freatic minerals and carbonate acid increases water content (Masriatini et al., 2019).

The Relationship Between Electrical Conductivity, Salinity, pH, and Odor

The relationship between electrical conductivity and salinity, pH, and odor in water is closely tied to the concentration of ions present in the water. Here is a detailed explanation of the relationship between electrical conductivity and these three parameters:

Salinity: Salinity refers to the concentration of dissolved salts and minerals in water. As salinity increases, the concentration of ions in the water also rises. Water containing a higher concentration of ions has a better ability to conduct electricity. Therefore, the higher the salinity of water, the higher its electrical conductivity.

pH: pH is a measure of the acidity or alkalinity of water. Water with different pH levels will have varying concentrations of hydrogen ions (H+) and hydroxide ions (OH-). Acidic water with a low pH will have more H+ ions, while alkaline water with a high pH will have more OH- ions. Both of these types of water will exhibit higher electrical conductivity than neutral pH water. Thus, there is a correlation between pH and electrical conductivity: the more extreme the pH, the higher the electrical conductivity.

Odor: Odor in water is typically caused by the presence of organic compounds or certain chemical compounds. While odor itself does not directly affect the electrical conductivity of water, it can serve as an indicator of the presence of specific compounds that can contribute to electrical conductivity. For example, organic salts can enhance water's electrical conductivity and may also produce a distinct odor.

In summary, the relationship between electrical conductivity and salinity, pH, and odor can be summarized as follows: the higher the salinity and the more extreme the pH, the greater the electrical conductivity of the water. Odor, on its own, may not be a primary factor in influencing electrical

conductivity but can be an indicator of the presence of compounds that affect electrical conductivity.

Domestic Water Needs

Domestic water needs are based on the daily use of water to meet household needs such as washing and some other needs that are fundamentally different. It can be seen that the most widely used water use is bath water, followed by washing water and other needs.

A Flownet is a map or construction that contains groundwater contour lines (equipotential lines) and groundwater flow lines (streamlines). Groundwater contour lines are lines that connect locations with the same hydraulic head (water table elevation). Groundwater contour lines indicate areas with the same water table elevation and can be constructed through interpolation from previously known water table elevations. Meanwhile, the direction of groundwater flow can be determined by drawing lines perpendicular to the contour lines of water table elevation. Flownets serve to determine the direction of groundwater flow, predict groundwater pollution pathways, estimate groundwater discharge rates and volumes in specific areas, identify recharge areas, and utilization areas, as well as detect changes in flow patterns or anomalies due to groundwater depletion. Some uses of flownets include: a. Determining the discharge rate in desired segments. b. Identifying recharge and discharge areas. c. Predicting the direction of groundwater pollution. d. Detecting changes in flow patterns or anomalies caused by human-induced groundwater overexploitation or other factors.

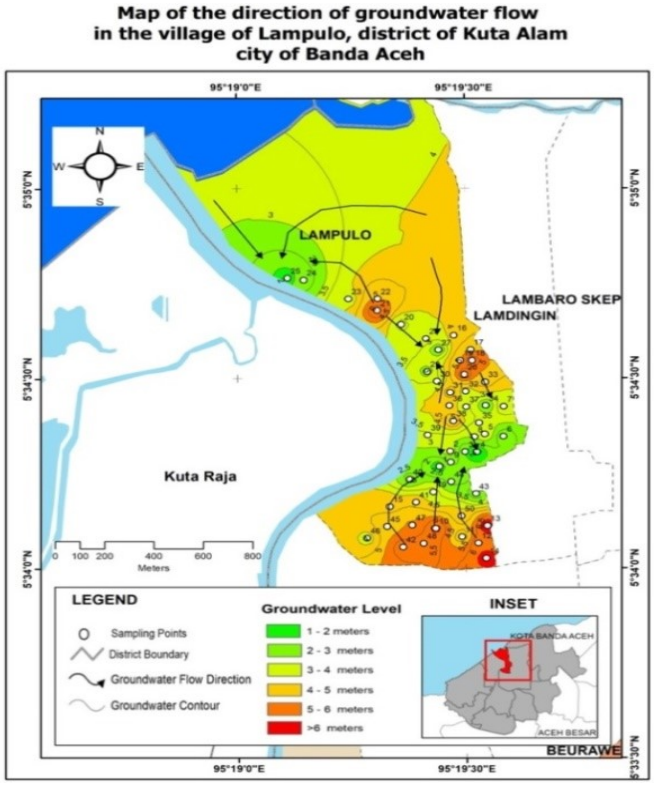

Figure 5. Map of the Direction of Groundwater Flow in Lampulo Village

The Flownet map is a two-dimensional picture of the groundwater flow. The areas with the highest waters of the earth are the areas of refurbishment, while the areas with lower waters are the regions ofdrainage. The initial stage that the researchers undertook to obtain a map of the direction of the soil water flow began with measuring each well. The depth of each well will be obtained for as many as 50 wells that exist in the research area using the grid sampling map. Based on the measurement of the height of the groundwater in the area of Lampulo, the surface level was at most in the range of 1.42 mdpl up to 6.78 mdpl.

From the analysis of map patterns of the directional flow of groundwater, it is seen that the direction of the flow of landwater follows the curve of the contour of the location of the study based on the high value of the surface water in the area of the research. Based on the results of the map of ground water flow patterns, it showed that there were values in the southern area of the surface of the high ground water, while in the northern area the surface water is low, so the pattern of the land water flow in the area of Lampulo proved that the ground water flows from the southern region to the northern region. It also indicated that at the site of the research, water flowed from the alluvial plains to the coastal area, as seen in the landwater flow direction map in Figure 5.

4. Conclusions

Based on the results of the research analysis of soil water quality based on the physical parameters of the dominant color (80% clear), the physical parameter of the dominant odor (100% odorless), the natural parameter of the dominant flavor (80% not felt), the DHL dominant parameter of freshwater (88%), and the pH parameter, the dominance of the base is about 68% due to the presence of carbonate, bicarbonate, and hydroxide. For domestic needs in the research area, the largest use of water is for bathing.

The depth of groundwater in the Lampulo region indicates that the groundwater height is in the range of 1.42 mdpl to 6.78 mdpl; the map of the water flow pattern of the southern part is higher compared to the northern part of the region; and it also shows that groundwater flowing from the south is the area of the alluvial plain towards the north, which is a coastal region.

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