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# Identifying Aquifer Layers Using the Vertical Schlumberger Configuration Resistivity Geoelectric Method in the Permata Hijau Housing Complex, Koya Barat Village, Muara Tami District, Jayapura

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## ABSTRACT

The study of aquifer layer identification using the Schlumberger vertical configuration resistivity geoelectric method was conducted in the Permata Hijau Housing Complex, West Koya, Muara Tami, Jayapura. The study aimed to determine the resistivity value, location, and depth of the aquifer layer. The methods include field geophysical surveys with the IREST300f tool for resistivity analysis and geophysical computational methods to obtain vertical soil profiles. The study was conducted at five measurement points. The results showed the presence of aquifer layers at each point with variations in resistivity and depth values. At point 1, there are two free aquifers with resistivities of 3.34 Ωm and 1.65 Ωm at depths of 4.95-8.80 m and 19.20-24.00 m. Point 2 has four aquifers with resistivities of 9.31 Ωm to 6.12 Ωm at depths of 3.00-76.00 m. Point 3 shows three aquifer layers with a resistivity of 5.61 Ωm to 1.61 Ωm at a depth of 3.40-97.00 m. Point 4 has two aquifers with resistivity of 9.30 Ωm and 4.52 Ωm at a depth of 4.28-57.40 m. Point 5 shows three aquifer layers with resistivity of 2.35 Ωm to 3.18 Ωm at a depth of 5.31-146.00 m. This study proves the existence of Free Aquifer type layers with variations in depth and resistivity at each point.

**Keywords:** Aquifer; Geoelectric Resistivity; Schlumberger; West Koya.



## 1. Introduction

Water is a basic human need in various aspects of life and is the main natural resource in daily activities. Difficulty and fulfillment of clean water can disrupt the smoothness of various daily activities [1-3]. Therefore, the usual method is to exploit groundwater to obtain water resources to meet daily needs [4]. Land exploitation for various purposes can be done in several ways, including making dug wells, commonly called culvert wells, for shallow groundwater exploitation (surface water) and drilling exploration wells for deep groundwater wells (aquifers) [5].

The existence of groundwater is not evenly distributed in every place and is closely related to its geological and geohydrological conditions [6]. Therefore, providing clean water by utilizing groundwater must be carried out through a study of groundwater potential in the area concerned [7-9]. It is necessary to explore groundwater to obtain data about the potential that can be developed while still paying attention to environmental sustainability. The process of exploiting groundwater must be done by paying attention to groundwater conditions and filling the aquifer layer back into the groundwater. To determine the existence of the aquifer layer, it is necessary to conduct groundwater research using the geoelectric method [10].

Permata Hijau Housing Complex is one of the housing complexes located in Koya Barat Village in the Muara Tami District of Jayapura City. Permata Hijau Housing greatly needs water from PDAM, but the housing development has not provided clean water from PDAM pipes; the solution still uses groundwater from drilled wells. The problem is that the clarity of the groundwater from drilled wells in Permata Hijau housing varies; some have clear, well water, and some are muddy or cloudy, so housing residents feel disappointed with the housing development because they have paid all the costs of the house, but have difficulty getting clean water. The availability of clean water is a problem in Permata Hijau housing. Research should be carried out using the geoelectric method to find out the potential of groundwater [11].

The geoelectric method is one of the geophysical methods used in identifying subsurface rock structures, especially in identifying groundwater [12-13]. The geoelectric method is used to measure the thickness of rock layers and identify aquifer layers because it utilizes the current flow into the earth's surface. The output results are apparent resistivity and potential differences using charges. This geoelectric method injects electric current into the earth's surface through a pair of current electrodes. Then, it measures the voltage between the two electrodes using a pair of potential electrodes connected to a voltmeter [14].

The purpose of this study was to determine the resistivity value of the aquifer layer in Permata Hijau Housing, Koya Barat Village, Muara Tami District, Jayapura City, and to determine the location and depth of the aquifer layer in Permata Hijau, Koya Barat Village, Muara Tami District, Jayapura City.

## 2. Method

This study uses field surveys and geophysical computation methods. The geophysical field survey method used is the geoelectric method. Field geophysical surveys obtain data on potential differences and electric current strength for field resistivity analysis. This computational method obtains the resistivity and soil layer profile in 1 dimension based on the actual resistivity value [15].

This study lasted for 8 months, from October 2023 to June 2024. The Permata Hijau Housing Complex is one of the housing complexes located in Koya Barat Village in the Muara Tami District, Jayapura City. The boundaries of Koya Barat Village are to the north bordering Holtekamp Village, Skouw Yambe Village, and Koya Tengah Village, to the south bordering Keerom Regency, to the west bordering Koya Koso Village, Abepura District, and to the east bordering Koya Timur Village. The following is the topographic map. The research location map is shown in Figure 1.

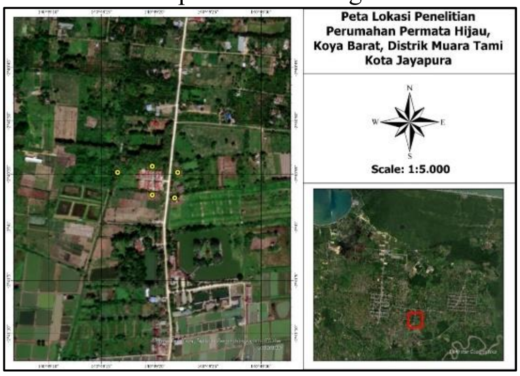


**Figure 1**. Research Location Map

The tools used in the study are:

a. Laptop, Functions to collect and process data generated from the Schlumberger configuration geoelectric tool.
b. Cable, Functions to flow current from the resistivity meter to the electrode.
c. Resistivity meter IREST300f, Functions to measure current and electric potential values.
d. Handy Talky, HT (Handy Talky) functions as a communication tool between partners in the study.
e. Meter, Functions to help determine the length and distance of the path and the distance between electrodes in each measurement.
f. Hammer, Functions as a beater in placing electrodes.
g. Current and potential electrodes, Functions to inject current into the ground and potential electrodes as determinants of the magnitude of the voltage difference that arises.
h. Battery, Functions as a current source in the process of using the Schlumberger configuration geoelectric tool.

Generally, the research procedure is carried out in 3 stages: preparation and data collection, data processing, and interpretation. In summary, the research procedure is shown in the flow diagram.

a. Preparation Stage
   The steps in the preparation stage are:
   1) Studying literature related to research journals
   2) Taking care of research permits and conducting field surveys
   3) Preparing equipment and conducting tests on tools to be used in the field
b. Stages of 1-dimensional Data Collection and Processing
   1) Spreading the meter as a place to check the electrode capture points
   2) Determining the sounding points AB (1.5) and MN/2 (0.5)
   3) Connecting to the current and potential terminals
   4) Adjusting the self-potential until the value approaches zero
   5) Turning on the Resistivity meter Model HV 500 equipment as a regulator of input and output current
   6) Pressing the START button on the tool and then pressing the Hold button on the Ampere meter and Volt meter
   7) Recording the data recorded on the tool in the form of current and potential values in the table provided
   8) Further measurements by moving the electrode according to the specified electrode distance.
   9) The field survey data is then input to the computer
   10) Calculation of apparent resistivity values
   11) After obtaining the resistivity value (q) and depth, the thickness of each layer was determined using IP2win software.

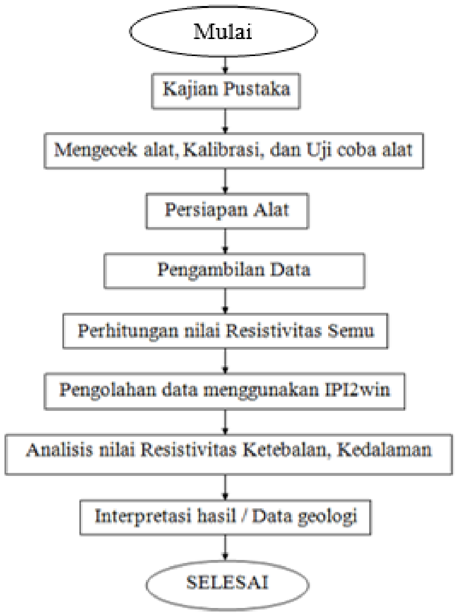


**Figure 2.** Research flowchart

## 3. Result and Discussion

Research on identifying aquifer layers using the 1-dimensional (vertical/sounding) geoelectric resistivity method has been carried out in Permata Hijau Housing, Koya Barat Village, Muara Tami District, Jayapura City. Data collection in 1 dimension (vertical/sounding) was carried out at five vertical points with the coordinate points shown in Table 1.

**Table 1.** Coordinates of the research location

| Titik | Longitude | Latitude | Span Length (m) | Elevation (masl) |
|---|---|---|---|---|
| 1 | 140°49'16.5" | -02°40'55.8" | 300 | 4 |
| 2 | 140°49'18.5" | -02°40'54.5" | 300 | 4 |
| 3 | 140°49'18.6" | -02°40'56.6" | 300 | 4 |
| 4 | 140°49'21.0" | -02°40'55.1" | 300 | 4 |
| 5 | 140°49'20.5" | -02°40'57.0" | 300 | 4 |

**Table 2.** Resistivity values of the vertical layer at point 1

| Layer (N) | Resistivity (Ωm) | Depth (m) | Thickness (m) | Formation | Type of Akuifer |
|---|---|---|---|---|---|
| 1 | 10.30 | 0.00-0.45 | 0.45 | Akuitard | |
| 2 | 57.00 | 0.45-0.81 | 0.35 | Akuitard | |
| 3 | 4.20 | 0.81-1.80 | 1.00 | Akuitard | |
| 4 | 73.00 | 1.80-2.03 | 0.24 | Akuitard | |
| 5 | 145.00 | 2.03-3.70 | 1.64 | Akuitard | |
| 6 | 75.60 | 3.70.4.18 | 0.51 | Akuitard | |
| 7 | 19.20 | 4.18-4.95 | 0.80 | Akuitard | |
| 8 | 3.34 | 4.95-8.80 | 3.81 | Akuifer | Free Aquifer type |
| 9 | 24.80 | 8.80-19.2 | 10.40 | Akuiklud | |
| 10 | 1.65 | 19.2-24.00 | 4.85 | Akuifer | Free Aquifer type |
| 11 | 0.53 | 24.00-37.00 | 13.00 | Akuifer | Free Aquifer type |
| 12 | 1.20 | 37.00-46.00 | 9.01 | Akuifer | Free Aquifer type |

**Table 3.** Resistivity values of the vertical layer at point 2

| Layer (N) | Resistivity (Ωm) | Depth (m) | Thickness (m) | Formation | Type of Akuifer |
|---|---|---|---|---|---|
| 1 | 16.30 | 0.00-1.03 | 1.03 | Akuitard | |
| 2 | 3.80 | 1.03-1.50 | 0.50 | Akuitard | |
| 3 | 90.40 | 1.50-1.80 | 0.30 | Akuitard | |
| 4 | 124.00 | 1.80-3.00 | 1.20 | Akuitard | |
| 5 | 9.31 | 3.00-6.80 | 3.80 | Akuifer | Free Aquifer type |
| 6 | 62.00 | 6.80-16.10 | 9.40 | Akuiklud | |
| 7 | 7.13 | 16.10-20.00 | 3.51 | Akuifer | Free Aquifer type |
| 8 | 0.50 | 20.00-27.20 | 7.53 | Akuifer | Free Aquifer type |
| 9 | 3.30 | 27.20-36.00 | 8.50 | Akuifer | Free Aquifer type |
| 10 | 25.10 | 36.00-53.00 | 17.00 | Akuiklud | |
| 11 | 6.12 | 53.00-76.00 | 23.20 | Akuifer | Free Aquifer type |
| 12 | 0.04 | 76.00-… | ….. | Akuifer | Free Aquifer type |

**Table 4.** Resistivity values of the vertical layer at point 3

| Layer (N) | Resistivity (Ωm) | Depth (m) | Thickness (m) | Formation | Type of Akuifer |
|---|---|---|---|---|---|
| 1 | 10.00 | 00.00-0.33 | 0.33 | Akuitard | |
| 2 | 23.20 | 0.33-1.00 | 0.53 | Akuitard | |
| 3 | 6.00 | 1.00-1.80 | 0.87 | Akuitard | |
| 4 | 101.00 | 1.80-3.40 | 1.64 | Akuitard | |
| 5 | 5.61 | 3.40-6.00 | 2.60 | Akuifer | Free Aquifer type |
| 6 | 19.00 | 6.00-7.00 | 0.70 | Akuitard | |
| 7 | 82.30 | 7.00-14.2 | 7.55 | Akuitard | |
| 8 | 22.00 | 14.2-15.5 | 1.40 | Akuitard | |
| 9 | 3.00 | 15.5-37.3 | 22.00 | Akuifer | Free Aquifer type |
| 10 | 42.00 | 37.3-68.5 | 31.20 | Akuitard | |
| 11 | 12.00 | 68.5-80.00 | 11.00 | Akuitard | |
| 12 | 1.61 | 80.00-97.00 | 18.00 | Akuifer | Free Aquifer type |

**Tabel 5.** Resistivity values of the vertical layer at point 4

| Layer (N) | Resistivity (Ωm) | Depth (m) | Thickness (m) | Formation | Type of Akuifer |
|---|---|---|---|---|---|
| 1 | 7.96 | 0.00-0.56 | 0.56 | Akuitard | |
| 2 | 85.10 | 0.56-0.86 | 0.30 | Akuitard | |
| 3 | 4.80 | 0.86-1.81 | 0.95 | Akuitard | |
| 4 | 24.10 | 1.81-2.03 | 0.22 | Akuitard | |
| 5 | 87.40 | 2.03-4.28 | 0.25 | Akuitard | |
| 6 | 9.30 | 4.28-7.35 | 3.10 | Akuifer | Free Aquifer type |
| 7 | 73.00 | 7.35-15.80 | 8.45 | Akuitard | |
| 8 | 58.20 | 15.80-19.40 | 19.40 | Akuitard | |
| 9 | 0.43 | 19.40-50.00 | 30.20 | Akuifer | Free Aquifer type |
| 10 | 4.52 | 50.00-57.40 | 7.85 | Akuifer | Free Aquifer type |
| 11 | 53.30 | 57.40-88.00 | 30.20 | Akuitard | |
| 12 | 35.00 | 57.40-115.00 | 27.40 | Akuitard | |

**Table 6.** Resistivity values of the vertical layer at point 5

| Layer (N) | Resistivity (Ωm) | Depth (m) | Thickness (m) | Formation | Type of Akuifer |
|---|---|---|---|---|---|
| 1 | 13.50 | 0.00-1.93 | 1.93 | Akuitard | |
| 2 | 35.50 | 1.93-1.98 | 0.05 | Akuitard | |
| 3 | 33.60 | 1.98-5.31 | 3.33 | Akuitard | |
| 4 | 2.35 | 5.31-5.65 | 0.34 | Akuifer | Free Aquifer type |
| 5 | 11.40 | 5.65-5.71 | 0.06 | Akuitard | |
| 6 | 147.00 | 5.71-6.73 | 1.02 | Akuitard | |
| 7 | 101.00 | 6.73-15.50 | 8.72 | Akuitard | |
| 8 | 8.38 | 15.50-39.00 | 23.50 | Akuifer | Free Aquifer type |
| 9 | 53.60 | 39.00-89.00 | 50.00 | Akuitard | |
| 10 | 24.50 | 90.00-93.40 | 4.52 | Akuitard | |
| 11 | 3.18 | 93.40-146.00 | 52.30 | Akuifer | Free Aquifer type |
| 12 | 150.00 | 146.00-…. | ….. | Akuitard | |

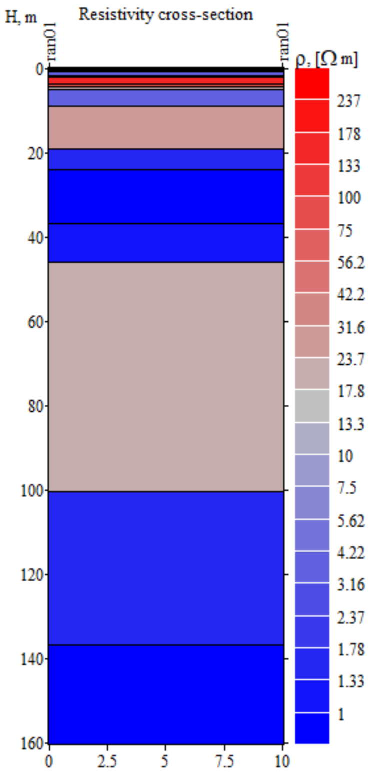


**Figure 3.** Vertical layer profile at point 1

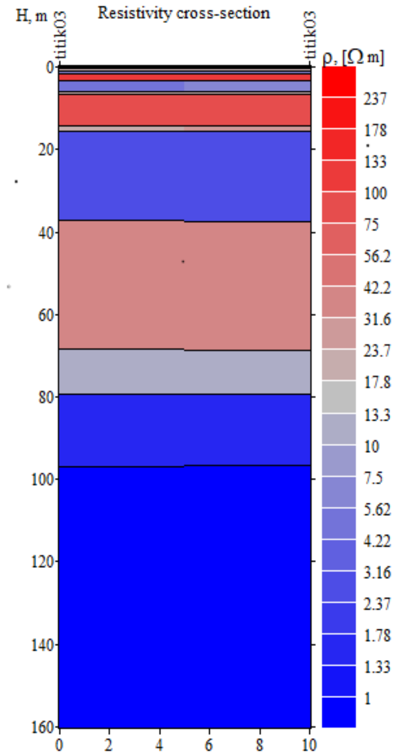


**Figure 5.** Vertical layer profile at point 3

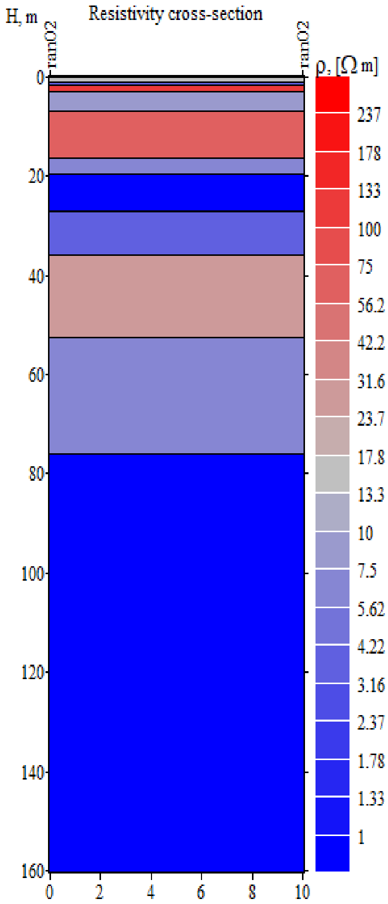


**Figure 4.** Vertical layer profile at point 2

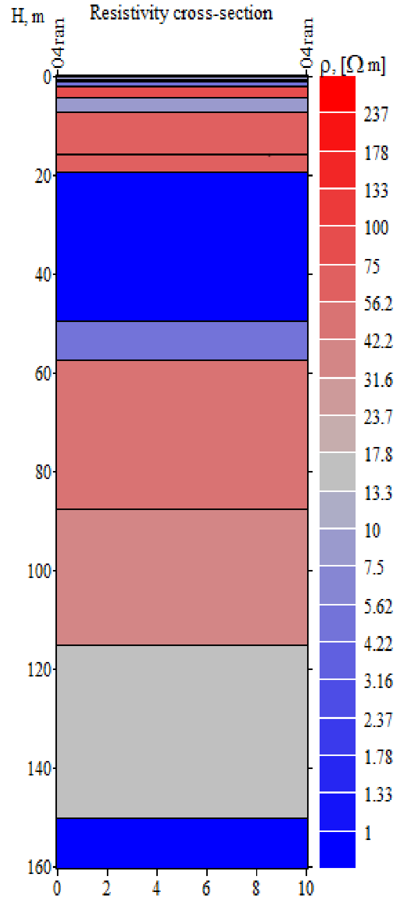


**Figure 6.** Vertical layer profile at point 4

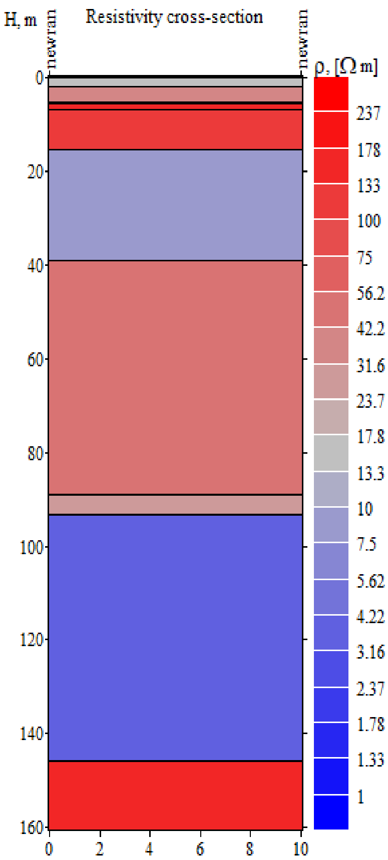


**Figure 7.** Vertical layer profile at point 5

a. Resistivity of Layer Point 1

The number of layers detected at point 1 is 12 layers. The calculation error value in the resistivity layer analysis at point 1 is 5.92%. Details of the resistivity layer values at point 1 are shown in table 2. The vertical layer profile at point 1 is shown in Figure 3.

b. Resistivity of Layer Point 2

The number of layers detected at point 2 is 12 layers. The calculation error value in the resistivity layer analysis at point 2 is 3.41%. Details of the resistivity layer values at point 2 are shown in table 3. The vertical layer profile at point 2 is shown in Figure 4.

c. Resistivity of Layer Point 3

The number of layers detected at point 3 is 12 layers. The calculation error value in the resistivity layer analysis at point 3 is 4.28%. Details of the resistivity layer values at point 3 are shown in table 4. The vertical layer profile at point 3 is shown in Figure 5.

d. Layer Resistivity Point 4

The number of layers detected at point 4 is 12 layers. The calculation error value in the resistivity layer analysis at point 4 is 5.24%. Details of the layer resistivity values at point 4 are shown in table 5. The vertical layer profile at point 4 is shown in Figure 6.

e. Layer Resistivity Point 5

The number of layers detected at point 5 is 12 layers. The calculation error value in the resistivity layer analysis at point 5 is 4.13%. Details of the layer resistivity values at point 5 are shown in table 6. The vertical layer profile at point 5 is shown in Figure 7.

Table 2 shows that there are 12 layers for point 1. Layer 1 has a resistivity value of 10.30 Ωm with a depth of 0-0.45 m and a thickness of 0.45 m. This layer's lithology type is surface soil in the form of soft limestone piles. Layer 2 has a resistivity value of 57.00 Ωm with a depth of 0.45-0.81 m and a thickness of 0.35 m, with the type of lithology in this layer being surface soil in the form of soft limestone piles. Layer 3 has a resistivity value of 4.2 Ωm with a depth of 0.81-1.80 m and a thickness of 1.00 m. This layer has a sandy silt soil lithology type. Layer 4 has a resistivity value of 73.00 Ωm with a depth of 1.80-2.03 m and a thickness of 0.24 m. This type of soil has a silt soil type and very little sand. Layer 5 has a resistivity value of 145.00 Ωm with a depth of 2.03-3.70 m and a thickness of 1.64 m. This layer has a silt soil lithology and is rather soft. Layer 6 has a resistivity value of 75.60 Ωm with a depth of 3.70-4.18 m and a thickness of 0.51 m. This layer contains silt soil type and very little sand. Layer 7 has a resistivity value of 19.20 Ωm with a depth of 4.18-4.95 m and a thickness of 0.80 m. This layer has a silt soil type and is a little sandy and soft. Layer 8 has a resistivity value of 3.34 Ωm with a depth of 4.95-8.80 m and a thickness of 3.81 m. This layer has silt and sandy soil types. This layer is very wet and soft because it contains groundwater and is a surface aquifer with a free aquifer type. Layer 9 has a resistivity value of 24.80 Ωm with a depth of 8.80-19.20 m and a thickness of 10.40 m. This layer's soil type is silt soil, which is a little sandy and soft. Layer 10 has a resistivity value of 1.65 Ωm with a depth of 19.20-24.00 m and a thickness of 4.85 m. This layer is of sandy silt soil type. This layer is very wet and soft because it contains surface groundwater (aquifer) with a free aquifer type. This layer is suspected to be contaminated by salt water. Layer 11 has a resistivity value of 0.53 Ωm with a depth of 24.00-37.00 m and a thickness of 13.00 m. This soil layer is sandy silt soil. This layer contains salty groundwater. Layer 12 has a resistivity value of 1.20 Ωm with a depth of 37.00-46.00 m and a thickness of 4.85 m. This layer is of sandy silt soil type. This layer is very wet and soft. It is a free aquifer layer, but it is suspected to be contaminated with salt water. So, Point 1 contains groundwater (free aquifer) seen in Layer 8 has a resistivity value of 3.34 Ωm with a depth of 4.95-8.80 m. and in Layer 10, it has a resistivity value of 1.65 Ωm with a depth of 19.20-24.00 m.

Table 3 shows that there are 12 layers for point 2. Layer 1 has a resistivity value of 16.30 Ωm with a depth of 0.00 - 1.03 m and a thickness of 1.03 m. The type of soil in this layer is a soft limestone embankment. Layer 2 has a resistivity value of 3.80 Ωm with a depth of 1.03-1.50 m and a thickness of 0.38 m. This layer's soil type is surface soil in the form of soft limestone debris embankment. Layer 3 has a resistivity value of 90.40 Ωm with a depth of 1.50-1.80 m and a thickness of 0.30 m. The type of soil is silt soil with very little sand. Layer 4 has a resistivity value of 124.00 Ωm with a depth of 1.80-3.00 m and a thickness of 1.20 m. The type of soil is silt soil with a slightly soft density. Layer 5 has a resistivity value of 9.31 Ωm with a depth of 3.00-6.80 m and a thickness of 3.80 m. it has a type of silt and sandy soil. This layer is very wet and soft because it contains groundwater and is a surface aquifer with a free aquifer. Layer 6 has a resistivity value of 62.00 Ωm with a depth of 6.80-16.10 meters and a thickness of 9.40 m; this layer has silt soil with very little sand. Layer 7 has a resistivity value of 7.13 Ωm with a depth of 16.10-20.00 m and a thickness of 3.51 m. it has silt and sandy soil types. This layer is very wet and soft because it contains groundwater, a surface aquifer with a free aquifer type. Layer 8 has a resistivity value of 0.50 Ωm with a depth of 20.00-27.20 and a thickness of 7.53 m. The soil type is sandy silt soil. This layer contains salty groundwater. Layer 9 has a resistivity value of 3.30 Ωm with a depth of 27.20-36.00 m and a thickness of 8.50 m. it has silt and sandy soil types. This layer is very wet and soft because it contains groundwater, a surface aquifer with a free aquifer type. Layer 10 has a resistivity value of 25.10 Ωm with a depth of 36.00-53.00 and a thickness of 17.00 m. This type of soil is slightly sandy and soft silt soil. Layer 11 has a resistivity value of 6.12 Ωm with a depth of 53.00-76.00 m and a thickness of 23.30 m. The type of soil is sandy silt soil. This layer is very wet and soft because it contains surface groundwater (aquifer) with a free aquifer type. Layer 12 has a resistivity value of 0.04 Ωm with a depth of 76.00 below. The type of soil is sandy silt. This very wet and soft layer is a free aquifer layer but is suspected of being contaminated with salt water. So, Point 2 contains groundwater (free aquifer) seen in Layer 5 has a resistivity value of 9.3 Ωm with a depth of 3.00-6.80 m. Layer 7 has a resistivity value of 7.13 Ωm with a depth of 16.10-20.00 m. Layer 9 has a resistivity value of 3.30 Ωm with a depth of 27.20-36.00 m. Layer 11 has a resistivity value of 6.12 Ωm with a depth of 53.00-76.00 m.

At point 3, 12 layers can be seen in table 4. Layer 1 has a resistivity value of 10.00 Ωm with a depth of 0.00-0.33 m and a thickness of 0.33 m. The type of soil is a soft limestone embankment. Layer 2 has a resistivity value of 23.20 Ωm with a depth of 0.33-1.00 m and a thickness of 0.53 m. The type of soil is a soft limestone embankment. Layer 3 has a resistivity value of 6.00 Ωm with a depth of 1.00-1.80 m and a thickness of 0.86 m. The type of soil in this layer is sandy silt. Layer 4 has a resistivity value of 101.00 Ωm with a depth of 1.80-3.40 m and a thickness of 1.64 m. This layer's soil type is silt with a slightly dense texture. Layer 5 has a resistivity value of 5.61 Ωm with a depth of 3.40-6.00 m and a thickness of 2.60 m. The soil type is silt and sandy soil. This layer is very wet and soft because it contains groundwater, a surface aquifer with a free aquifer type. Layer 6 has a resistivity value of 19.00 Ωm with a depth of 6.00-7.00 m and a thickness of 0.70 m. The soil type is silt and a little sandy. Layer 7 has a resistivity value of 82.30 Ωm with a depth of 7.00-14.2 m and a thickness of 7.55 m. The soil type is silt and very little sandy. Layer 8 has a resistivity value of 22.00 Ωm with a depth of 14.20-15.00 m and a thickness of 1.40 m. The type of soil layer is silt and slightly sandy. Layer 9 has a resistivity value of 3.00 Ωm with a depth of 15.50-37.30 m and a thickness of 22.00 m. The type of soil is silt and sandy. This layer is very wet and soft because it contains groundwater and is a surface aquifer with a free aquifer type. Layer 10 has a resistivity value of 42.00 Ωm with a depth of 37.30-68.50 m and a thickness of 31.20 m. The type of soil is silt and slightly sandy. Layer 11 has a resistivity value of 12.00 Ωm with a depth of 68.50-80.00 m and a thickness of 11.00 m. The type of soil is silt and slightly sandy. Layer 12 has a resistivity value of 1.61 Ωm with a depth of 80.00-97.00 m. The type of soil is silt and sandy soil. This layer is very wet and soft because it contains groundwater, a surface aquifer with a free aquifer type. So, Point 3 contains groundwater (free aquifer) seen in Layer 5, which has a resistivity value of 5.61 Ωm with a depth of 3.40-6.00 m. Layer 9 has a resistivity value of 3.00 Ωm with a depth of 15.50-37.30 m. and Layer 12 has a resistivity value of 1.61 Ωm with a depth of 80.00-97.00 m.

At point 4 measurement, 12-layer structures can be seen in table 5. Layer 1 has a resistivity value of 7.96 Ωm with a depth of 0-0.56 m and a thickness of 0.56 m. The type of soil is a soft limestone embankment. Layer 2 has a resistivity value of 85.10 Ωm with a depth of 0.56-0.86 m and a thickness of 0.30 m. The type of soil in this layer is a soft limestone embankment. Layer 3 has a resistivity value of 4.80 Ωm with a depth of 0.86-1.81 m and a thickness of 0.95 m; the soil type is a soft limestone embankment. Layer 4 has a resistivity value of 24.10 Ωm with a depth of 1.81-4.28 m and a thickness of 0.22 m; this layer's soil type is silt and a little sandy. Layer 5 has a resistivity value of 87.40 Ωm with a depth of 2.03 - 4.28 m and a thickness of 0.22 m. The type of soil is silt and very little sand. Layer 6 has a resistivity value of 9.30 Ωm with a depth of 4.28-7.35 m and a thickness of 3.10 m. The type of soil is silt and sandy soil. This layer is very wet and soft because it contains groundwater, a surface aquifer with a free aquifer type. Layer 7 has a resistivity value of 73.00 Ωm with a depth of 7.35-15.80 m and a thickness of 8.45 m; this layer has silt and very little sand. Layer 8 has a resistivity value of 58.20 Ωm with a depth of 15.80 m and a thickness of 19.40 m, with the soil type being silt and a little sandy. Layer 9 has a resistivity value of 0.43 Ωm with a depth of 19.40-50.00 m and a thickness of 30.20 m. The soil type is sandy silt. This layer contains salty groundwater. Layer 10 has a resistivity value of 4.52 Ωm with a depth of 50.00-57.40 m and a thickness of 7.85 m. The soil type is silt and sandy. This layer is very wet and soft because it contains groundwater, a surface aquifer with a free aquifer type. Layer 11 has a resistivity value of 53.30 Ωm with a depth of 57.40-88.00 m and a thickness of 30.20 m; this layer's soil type is silt and very little sandy. Layer 12 has a resistivity value of 35.00 Ωm with a depth of 57.40-115.00 m and a thickness of 27.40 m; this layer's soil type is silt and a little sandy. So, Point 4 contains groundwater (free aquifer) seen in Layer 6 has a resistivity value of 9.30 Ωm with a depth of 4.28-7.35 m. and Layer 10 has a resistivity value of 4.52 Ωm with 50.00-57.40 m.

At point 5 there are 12 layers which can be seen in table 6. Layer 1 has a resistivity value of 13.50 Ωm with a depth of 0.00 - 1.93 m and a thickness of 1.93 m. The type of soil is soft limestone embankment. Layer 2 has a resistivity value of 35.50 Ωm with a depth of 1.93-1.98 m and a thickness of 0.05 m. The type of soil is soft limestone embankment. Layer 3 has a resistivity value of 33.60 Ωm with a depth of 1.98-5.31 m and a thickness of 3.33 m. The type of soil in this layer is silt and slightly sandy. Layer 4 has a resistivity value of 2.35 Ωm with a depth of 5.31-5.65 m and a thickness of 1.02 m. The type of soil in this layer is silt and sandy. This layer is very wet and soft because it contains groundwater, it is a surface aquifer with a free aquifer type. Layer 5 has a resistivity value of 11.40 Ωm with a depth of 5.65-5.71 m and a thickness of 0.06 m. The type is silt and slightly sandy soil. Layer 6 has a resistivity value of 157.00 Ωm with a depth of 5.71-6.73 m and a thickness of 1.02 m. The type of soil is silt and slightly soft dense soil. Layer 7 has a resistivity value of 101.00 Ωm with a depth of 6.73-15.50 m and a thickness of 8.72 m. The type of soil is silt and slightly soft dense soil. Layer 8 has a resistivity value of 8.38 Ωm with a depth of 15.50-39.00 m and a thickness of 23.50 m. The soil layer is made up of silt and sandy soil. This layer is very wet and soft because it contains groundwater, a surface aquifer with a free aquifer type. Layer 9 has a resistivity value of 53.60 Ωm with a depth of 39.00-89.00 m and a thickness of 50.00 m. The type of soil is silt and slightly sandy. Layer 10 has a resistivity value of 24.50 Ωm with a depth of 90.00-93.40 m and a thickness of 4.52 m. The type of soil is silt and slightly sandy. Layer 11 has a resistivity value of 3.18 Ωm with a depth of 93.40-146.00 m and a thickness of 52.3 m. The type of soil is silt and sandy soil. This layer is very wet and soft because it contains groundwater, a surface aquifer with a free aquifer type. Layer 12 has a resistivity value of 150.00 Ωm with a depth of 146.00 down. The type of soil is silt and rather soft and dense. So, Point 3 contains groundwater (free aquifer) seen in Layer 4, which has a resistivity value of 2.35 Ωm with a depth of 5.31-5.65 m. Layer 8 has a resistivity value of 8.38 Ωm. Layer 11 has a value of 3.18 Ωm with a depth of 93.40-146.00 m.

## 4. Conclussion

At point 1, there are two layers of the unconfined aquifer with a resistivity of 3.34 Ωm and 1.65 Ωm. At point 2, there are four layers of the unconfined aquifer with a resistivity of 9.31 Ωm, 7.13 Ωm, 3.30 Ωm, and 6.12 Ωm. At point 3, there are three layers of the unconfined aquifer with a resistivity of 5.61 Ωm, 3.00 Ωm, and 1.61 Ωm. At point 4, there are two layers of the unconfined aquifer with a resistivity of 9.30 Ωm and 4.52 Ωm. At point 5, there are three layers of the unconfined aquifer with a resistivity of 2.35 Ωm, 8.38 Ωm, and 3.18 Ωm. The unconfined aquifer layer is visible at point 1, located in layer 8 with a depth of 4.95-8.80 m and layer 10 with a depth of 19.20-24.00 m. The unconfined aquifer layer is visible at point 2, located in layer 5 with a depth of 3.00-6.80 m and layer 7 with a depth of 16.10-20.00 m. layer 9 with a depth of 8.80-19.20 m and layer 11 6.12 Ωm with a depth of 53.00-76.00 m. The unconfined aquifer layer is visible at point 3, located in layer 5 with a depth of 3.40-6.00 m, layer 9 with a depth of 15.50-37.30 m, and layer 12 with a depth of 80.00-97.00 m. The unconfined aquifer layer is visible at point 4, layer 6 with a depth of 4.28-7.35 m. and Layer 10 with a depth of 50.00-57.40 m. The free aquifer layer is seen at point 5, Layer 4, with a depth of 5.31-5.65 m. Layer 8 has a depth of 15.50-39.00 m, and layer 11 has a depth of 93.40-146.00 m.

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