Characteristics and Potential of Confined Aquifers in Genuk and Surrounding Area, Semarang City, Central Java Province

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ABSTRACT

The city of Semarang, especially the Genuk area and its surroundings, is currently categorized as a critical zone for groundwater utilization because of the large groundwater abstraction discharge and poor groundwater quality. To fulfill the need for clean water, both for domestic and industrial purposes, groundwater is used to a depth of 150 masl, but it is still not fully fulfilled, especially for large-scale industries. Therefore, it is necessary to investigate the existence or potential of aquifers that are below a depth of more than 150 masl. The method used was a VES geoelectric survey with a Schlumberger configuration, drilling test wells, well electrical logging resistivity and Self Potential (SP) methods as well as porosity and permeability tests of aquifer samples from a depth of more than 150 mdpt.The results of the geoelectrical interpretation show the presence of an aquifer carrying layer at a depth of 135 – 220 meters. Meanwhile, from the measurement *well electrical logging* confined aquifer carrier layer at a depth of 160 - 176 meters and 188 - 210 meters. The characteristics of the aquifer at a depth of 160 – 176 meters have a porosity value of 2.9 – 8.22% and a hydraulic conductivity value of 0.017 – 0.036 m/day. The characteristics of the aquifer at a depth of 188 – 210 meters have a porosity value of 11.6 – 19.899% and a hydraulic conductivity value of 0.09 – 0.23 m/day. The results of this investigation generally indicate that there was a potential for depressed aquifers in this area at depths of more than 150 masl.

Keywords: Characteristics of aquifers, confined aquifers, geoelectricity, well electrical logging

1. PRELIMINARY

The city of Semarang as the capital of Central Java Province is a city with a high population, in 2020 it will be 1,653,524 people and a population growth rate of 0.59 [1]. In addition, Semarang City has a fairly important role in the economy of Central Java Province because it is located on the economic traffic lane of the island of Java, so it has rapid economic activity and many industrial areas are found, especially in the northern part of Semarang City to its sub-urban areas such as Demak Regency. Economic improvement and rapid population growth will have an impact on changes in land use functions which will also have a negative impact on several natural resources, one of which is groundwater. In 2010 there was a decrease in the groundwater level to -50 meters below sea level (mbsl) which caused the formation of a groundwater cone and seawater intrusion in the northern part of Semarang City [6]. Locations of significant groundwater subsidence are located in Genuk District, Semarang City and Sayung District, Demak, this indicates that there is excessive groundwater extraction which is thought to be carried out by the industry in that location. The industrial players in the research area almost entirely utilize groundwater to meet their raw water needs because there is no clean water company that passes through the location. The Department of Energy and Mineral Resources Central Java Province (2021) noted that the average production well in Semarang City utilizes groundwater in confined aquifers at a depth of 60 – 120 mbml, including Genuk and its surroundings. In 2020 - 2021, Department of Energy and Mineral Resources Central Java Province will conduct a groundwater exploration study regarding the potential for depressed aquifers below a depth of 150 mdpt in the area which is expected to be used as an alternative in meeting their raw water needs.

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1.1 Research Sites

This research was conducted in the Genuk area and its surroundings, Semarang City, Central Java Province (Figure 1) using the VES geoelectric survey method with the Schlumberger configuration, drilling test wells, well electrical logging with resistivity and Self Potential (SP) methods as well as porosity and permeability tests for samples. aquifer from a depth of more than 150 meters above sea level. Administratively, the research area is divided into 2 (two) regions, namely Semarang City and Demak Regency. The area of Semarang City includes the Districts of North Semarang, Genuk, Pedurungan, and Gayamsari. Meanwhile, Demak Regency includes 3 (three) Districts, namely Sayung, Mranggen, and Guntur.

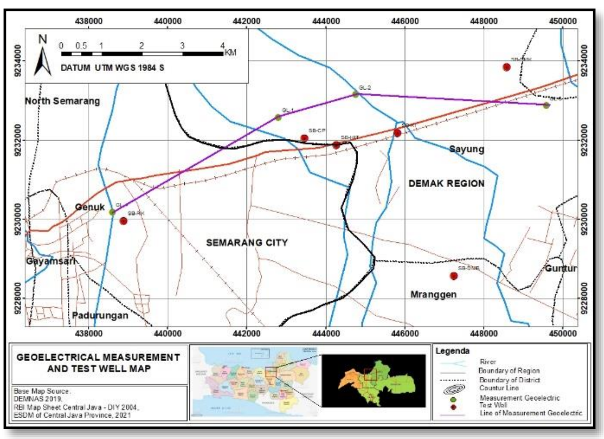

Figure 1. Map of the location of the research area

1.2 Geology

1.2.1 Stratigraphy

The stratigraphy of the study area has a stratigraphic arrangement from the youngest to the oldest as follows:

1.2.1.1 Alluvium deposit

This unit is composed of clay, silt, sand and a mixture with a thickness of up to 50 m or more. River and lake deposits consist of gravel, gravel, sand and silt with a thickness of 1 - 3 m. The chunks are composed of andesite, claystone and a little sand. This unit has an area of 80% of the entire study area.

1.2.1.2 Volcanic Breccia,

This unit is gray-black in color, with basaltic fragment composition, measuring 1 - 20 cm, slightly rounded, slightly hard. This unit has an area of 20% of the entire study area. This unit is also composed of tuffaceous sandstone with fine-medium grain size and brownish yellow color.

1.2.2 Geomorphology

In general, the geomorphology of the research area and its surroundings has reliefs in the form of flat topography to gently undulating. The slope of the slope varies, from 0% - 2% to 15% - 25%. The flow pattern in this area forms a parallel flow pattern. Based on the appearance of the landscape and geological processes in the research area, the geomorphology of this area is divided into 4 (four) morphological units, namely:

1.2.2.1. Plain Morphological Unit

Flat topographic units are characterized by slopes ranging from 0% -8% with a height difference of <5 meters. This morphological unit is formed by a unit that is strongly dominated by alluvium and is a flood plain, formed by loose sedimentary materials from land which are generally sand-clay in size, local gravel to boulders where sediment accumulation occurs. Flat topographic units are mostly used by residents as ponds and residential areas.

1.2.2.2. Morphological Unit of Sloping Hills

This morphological unit is characterized by slopes ranging from 8% - 15% with a height difference ranging from 25 m-50 m. This morphological unit is formed by tuffaceous sandstone. This morphology is mostly used by residents as moor, gardens, irrigated rice fields, and residential areas.

1.2.2.3. Corrugated Hills Morphological Unit Slightly Steep

This morphological unit is characterized by slopes ranging from 15% - 25% with height differences ranging from 50 m-100 m. Unit This morphology is formed by volcanic breccia. This morphology is mostly used by residents as moor, gardens, irrigated rice fields, and residential areas.

1.2.3 Geological Structure

Geological structures in the Semarang area are generally in the form of faults consisting of normal faults, shear faults and rising faults. The normal fault is trending towards the west-east, partly slightly convex to the north, the shear fault is trending north-south to the northwest-southeast, while the normal fault is trending relatively west-east. These faults generally occur in the Kerek Formation, Kalibening Formation and Damar Formation which are quaternary and tertiary in age.

2. METHOD

This study is intended to determine the value of rock type resistance and its rock types as well as to determine the value of hydraulic conductivity and distribution characteristics of the aquifer. And the aim of this research is to calculate the groundwater potential in the confined aquifer (more than 150 meters deep) in the Genuk area and its surroundings (Figure 2).

2.1 Geoelectric Measurement

Geoelectrical measurement is one of the resistivity geophysical methods, which is a geophysical method to estimate the subsurface geological conditions, especially the types and properties of rocks based on the electrical properties of rocks. The data on the electrical properties of rocks in the form of resistivity are grouped and interpreted by taking into account the existing local geological conditions, especially for areas that have a fairly clear contrast of resistivity with respect to their surroundings, one of the uses of which is for groundwater exploration. This measurement uses the Schlumberger Vertical Electrical Sounding (VES) method (Figure 3), aiming to determine variations in the vertical arrangement of underground rock layers, namely by providing an electric current into the soil and recording the measuring potential difference.

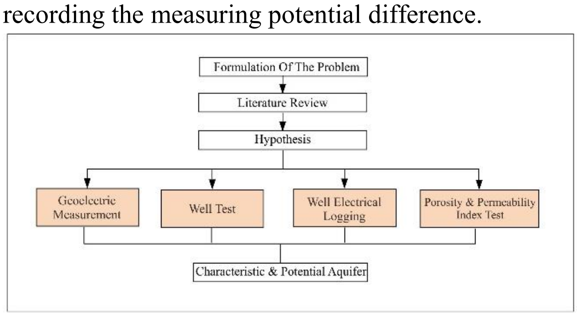

Figure 2. Metode of research

Geoelectric measurements were carried out around the Semarang-Demak industrial area as much as 4 (four) points. The first point of measurement is at UTM coordinates WGS (1984) Zone 49S442807 mE; 9232577 mS in Sriwulan, Sayung. The second point is at coordinates 444756 mE; 9233153 mS in Purwosari, Sayung. The third point is at coordinates 449588 mE; 9232874 mS in Loireng, Sayung. The fourth point is at coordinates 438603 mE; 9230183 mS in Kaligawe, Gayamsari.

Figure 3. Geoelectrical measurement at point GL-1

2.2 Test Well

Drilling of test wells was carried out to determine the subsurface conditions at the research site, both lithological conditions, rock stratigraphy and groundwater aquifer conditions vertically. There are two drilling methods used in the manufacture of test wells, namely drilling by taking samples of rock core (coring) and drilling mud (cutting).

The construction of test wells is carried out by several private companies that will utilize groundwater at the research site and the Department of Energy and Mineral Resources Central Java Province, as policy makers in groundwater management in the area. There are 6 (six) points for making test wells, namely SB-HIK (PT. Hartono Istaka Teknologi) with coordinates of 444290804 mE and 9232267.358 mS. SB-KI (PT. Kinofood Indonesia) with coordinates 445834,526mE, 9232772.281 mS. SB-RK (Kaligawe Flats/ Exploration Well 1 Department of Energy and Mineral Resources Central Java Province) with coordinates 438894.561 mE, 9229950.113 mS. SB-SMK (SMK N 1 Sayung, Demak Regency/ Exploration Well 2 Department of Energy and Mineral Resources Central Java Province) with coordinates 448593.595 mE, 9233840.354 mS. SB-DMB (Dombo, Sayung) with coordinates 447262594 mE and 9228566.916 mS. SB-CPI (PT. Charoen Pokphand Indonesia) with coordinates 443476.

2.3 Well Electrical Logging

*Well electrical well logging*is the recording of the physical properties of the rock, in this case the electrical value (resistivity) and self potential of each layer. The electrical properties of rocks are part of the interpretation of rock layers containing water (aquifers), for that the higher the resistivity value of the rock mass, the greater the water content in the rock layers. and has an inverse value to the conductivity of water. This measurement is carried out at the time of making the test well where the drilling and enlargement of the borehole have been completed with the aim of ensuring the vertical arrangement of rock layers based on the electrical value of the rock. There are 6 (six) well electrical logging measurement points taken from the test wells SB-HIK, SB-KI, SB-RK, SB-SMK, SB-DMB, and SB-CPI.

2.4 Porosity and Permeability Index Test

The porosity and permeability index testing was carried out at the Rock Core Analysis Laboratory, Petroleum Engineering Study Program, UPN Yogyakarta usingNatural Water Content method based on the AASHTO T100-90 testing standard. Testing of rock porosity and permeability index must use rock core samples (coring) so that only 3 (three) test wells are taken, namely SB-RK, SB-SMK and SB-HIK. For the SB-HIK test well, only one sample was tested at a depth of 203 meters, while for the SB-RK test well, it was taken from a depth of 166 meters and 205 meters. The SB-SMK test well contained 4 (four) samples taken from a depth of 151 meters, 165 meters, 171 meters and 206 meters.

3. RESEARCH RESULT

3.1 Geoelectric Measurement

From the results of the geoelectrical analysis, the arrangement of each layer is as follows: rock layers in Sriwulan Village from bottom to top Clay, clayey sand, clay and overburden. The composition of rock layers in Purwosari from the bottom to the top Sandy clay, loamy sand, clay and overburden. The composition of rock layers in Loireng Village from bottom to top is clay, sand, clay, clay sand, clay, and overburden. The composition of rock layers in Kaligawe from bottom to top is clay, sandy loam, clay, clayey sand, clay, sandy clay, and overburden (Table 1).

From the information above, the results confined that the groundwater carrier layer (aquifer) in Sriwulan, Sayung, Demak is clay sand at a depth of 53.65 m - 120.38 m, with a thickness of 66.73 m. Purwosari Village, Sayung District, Demak Regency: the aquifer layer is loamy sand at a depth of 53.91 m - 96 m, with a thickness of 42.9 m and sandy clay with a thickness of 123 m at a depth of 97 m – 220 m. Loireng, Sayung District, Demak Regency: the aquifer layer is clay sand at a depth of 15.21 m - 40.67 m, with a thickness of 25.46 m, and sand at a depth of 135.16 m - 160.85 m, with a thickness of 25.69 m. Kaligawe, Gayamsari District, Semarang City: the aquifer layer is clay sand at a depth of 54.75 m - 62.4 m with a thickness of 7.65 m and sandy clay at a depth of 75.2 m – 220.76 m below the surface with a thickness of ±145.56 m.

The results of geoelectrical estimation in the field can be correlated to describe the distribution of rocks in the research area. Correlation at each point is carried out by taking into account the type of lithology and geological formation at each point of estimation. The A-A' incision which runs west-east passes through points GL-4, GL-1, GL-2, and GL-3 located in Gayamsari and Sayung sub-districts (Figure 4). This incision completely traverses the Alluvium (Qa) deposit. The A-A' incision consists of overburden, clay, loamy sand, sand and sandy clay. The correlation results show that the subsurface conditions of the investigation site are generally in the form of a layer of clay and a thick layer of sandy clay. At the top of the continuous Clay layer at all GL locations. Clay Sand layer continuously from GL-4 to GL-1, GL-2, and GL-3. Sandy clay layers are found locally at GL-4 and GL-2 and are not continuous. Sand Layers are only found in GL-3. The correlation of the fence diagram is trending West-East starting from GL-4 through points GL 1, GL-2, GL-3 and back to GL 4. As shown in (Figure 5). When associated with regional geology, this correlation is in Alluvium (Qa) deposits.

Based on the 3D geoelectrical cross-section, the aquitar layer is a sandy clay layer, where is depicted as a light green layer, while the aquiclud layer is a clay and depicted on the cross section with dark green color. The layers that become the aquifer are the sand layer and the clay sand layer, where the cross section is depicted with a yellow and a light yellow color

Table 1 Geoelectrical measurement results at the research site

Point	Depth (m)	Thickness (m)	Resistivity (m)	Lithol-ogy
GL-1	0 -1.42	1.42	1.65 - 8.52	Cover Land
	1.42 – 53.65	52.23	0.1 – 2.21	Clay
	53.6 - 120.38	66.76	26.12	Clay Sand
	120.38 – 219.86	99.48	8.04	Clay
GL-2	0 - 1.17	1.17	12.37	Cover Land
	1.17 – 53.91	52.74	0.29 – 2.67	Clay
	53.91 - 96.1	42.19	28.58	Clay Sand
	96.1 – 216.65	120.55	13.72	Sandy clay
GL-3	0 - 0.9	0.9	34.74	Cover Land
	0.9 - 15.21	14.31	0.76 - 4.23	Clay
	15.21 - 40.67	25.46	24.31 – 34.9	Clay Sand
	40.67 – 137.16	9.49	1.77	Clay
	137.16 - 166.85	29.69	35.03	Sand
	166.85 – 170	3.15	0.91	Clay
GL-4	0 - 1.15	1.15	6.91	Cover Land
	1.15 - 4.46	3.31	11.5 - 15.02	Sandy Clay
	4.46 – 54.75	50.29	0.62 - 3.63	Clay
	54.75 - 62.4	7.65	21.63	Clay Sand
	62.4 – 75.2	12.8	4.93	Clay
	75.2 – 220.76	145.5	10.51	Sandy Clay

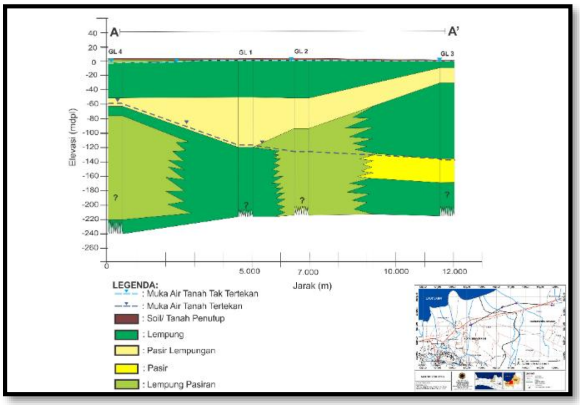

Figure 4. Section A-A' geoelectric correlation

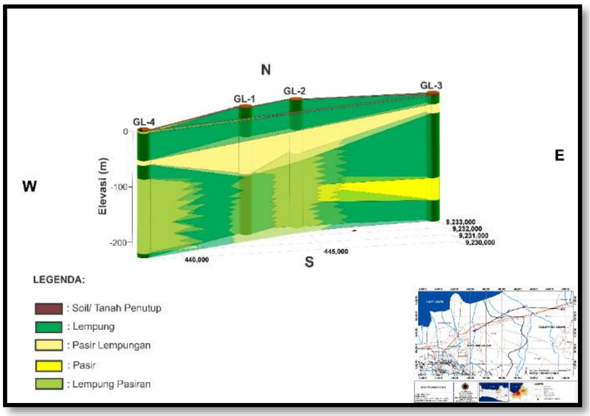

Figure 5. Correlation of 3D geoelectrical sectio

3.2 Test Well

From the results of making test wells, only SB-RK used the coring method of sampling from a depth of 0 – 210 meters which is described in Table 2.

Table 2 Analysis of rock core samples in SB-RK

Depth (m)	**Type of lithology**	**Lithological conditions**
0 – 0.7	*top soil*	*Unconsolidate*
0.7 – 21	Clay sand - sand	*Semiconsolidate*
21 – 81.3	Clay	*Semiconsolidate*
81.3 – 187.5	Sandy loam - sand	*Semiconsolidate - Consolidate*
187.5 – 196	Sand - gravel	*Consolidate*
196 – 210	Sandy loam - sand	*Consolidate*

For the SB-SMK test wells, the sampling method of drilling mud (cutting) at a depth of 0-150 meters and rock core (coring) at a depth of 150-210 meters is described in Tables 3 and 4. SB-HIK uses the drilling mud sampling method (cutting) with the analysis results described in Table 5.

Figure 6. Rock core samples in SB-RK

Table 3 Analysis of SB-SMK cutting sample results

Depth (m)	**Type of lithology**
0 – 4	*Top Soil*
4 – 63	Clay
63 – 72	Sandy clay
72 – 90	loamy sand
90 - 93	Fine sand
93 - 106	loamy sand
106 – 126	Sandy clay
126 – 150	loamy sand

Table 4 Analysis of the results of SB-SMK cor coring samples

Depth (m)	**Type of lithology**	**Lithological conditions**
150 – 161.8	Sandy clay	*Semi Consolidated*
161.8 – 165	Clay	*Consolidate - Semiconsolidate*
165 – 172.5	Clay Sand	*Consolidate - Semiconsolidate*
172.5 – 204.7	Sandy Clay	*Semiconsolidate*
204.7 – 207.9	Sand	*Consolidate*
207.9 – 210	Sandy clay	*Consolidate - Semiconsolidate*

Table 5 Analysis of SB-HK . cutting sample results

Depth (m)	Type of lithology
0 – 2	Cover Land
2 – 106	Clay
106 – 111	Sandy clay
111 – 119	Clay
119 – 124	Sandy Clay
124 – 131	Clay
131 – 133	Sandy Clay
133 – 141	Clay
141 – 155	Sandy Clay
155 – 160	Clay
160 – 185	Sandy Clay
185 – 196	Clay
196 – 205	Sandstone

Figure 7. Sampling of cuttings on SB-HIK

In the SB-KI test well, samples were also taken in the form of drilling mud with the analysis in Table 6.

Table 6 Analysis of SB-KI . cutting sample results

Depth (m)	Type of lithology
0 – 3	Cover Land
3 – 90	Clay
90 – 96	Sandy clay
96 – 105	Clay
105 – 133	Sandy Clay
133 – 152	Clay
152 – 171.5	Sandy Clay

3.3 Well Electrical Logging

Logging data retrieval is based on two main methods, namely resistivity and potential self. Each of the two methods has a different function, the resistivity is used to determine the position of the rock layers in the borehole based on the value of the resistivity of each rock layer in the borehole directly. The potential self method is used to determine the potential value generated by the rock itself. Investigations using this method are to distinguish salty and freshwater aquifers. The measurement results using this method are then compared with the results of the resistivity measurement. If the price of resistivity is high while the price of this self potential shows an increase in price, then most likely the aquifer contains high levels of Cl. The results of the well electrical logging measurements from the test wells are described in the table below.

Table 7 Results of logging measurements on SBDMB

Depth (m)	Observation result		Lithology
	SP(mV)	Resistivity (Ohms)	
0 – 8	-	-	Cover Land
8 – 31	20 - 28	22 - 24	Clay
31 – 39	21 - 23	20 - 22	Clay
39 – 51	20 - 28	22 - 24	Clay
51 – 61	20 - 28	22 - 24	Clay
61 – 74	23 - 26	20 - 22	Clay
74 – 83	22 - 28	20 - 22	Clay
83 – 98	20 - 21	24 - 27	Sandy Clay
98 – 103	30 - 36	25 - 38	Sand
103 – 116	21 - 33	24 - 27	Clay
116 – 122	36 - 39	20 - 59	Sand
122 -127	34 - 38	23 - 27	Clay
127 - 140	30 - 48	24 - 59	Sand

Table 8 Results of logging measurements on SB-RK

Depth (m)	Observation result		Lithology
	SP(mV)	Resistivity (Ohm)	
0 – 4	259 – 262	12 – 16	Cover Land
5 – 15	259 – 278	12 – 36	loamy sand
16 – 20	259 – 264	12 – 18	Sandy clay
21 – 34	254 – 259	6 – 12	Clay
35 – 37	259 – 263	12 – 17	Sandy clay
38 – 60	254 – 258	6 – 11	Clay
61 – 62	258 – 261	11 – 14	Sandy clay
63 – 81	255 – 258	7 – 10	Clay
82 – 85	257 – 262	9 – 15	Sandy clay
86 – 90	259 – 272	12 – 28	loamy sand
91 – 93	261 – 263	14 – 17	Sandy clay
94 – 95	262 – 270	15 – 26	loamy sand
96 – 97	259 – 295	12 – 57	conglomerate rock
98 – 104	258 – 263	10 – 17	Sandy clay
105 – 106	258 – 292	11 – 53	conglomerate rock
107 – 111	258 – 262	10 – 15	Sandy clay
112 – 113	258 – 258	10 – 11	Clay
114 – 118	259 – 278	17 – 42	loamy sand

Table 9 Results of logging measurements for SBSMK

Depth (m)	Observation result		Lithology
	SP(mV)	R(Ohms)	
0 – 5	0	0	Cover Land
6 – 159	36 – 63	4-5	Clay
160 – 163	75 – 89	6 – 13	Sand
164 – 168	67 – 72	5 – 5	Clay
169 – 176	25 – 68	5 – 6	Sandy clay
177 – 187	10 – 26	3 – 4	Clay
188 – 210	7 – 29	3 – 5	Sandy clay

Table 10 Results of logging measurements on SB-CPI

Depth (m)	Observation result		Lithology
	SP(mV)	R (Ohms)	
0 – 20	-	-	Cover Land
20 – 30	34 – 46	5 – 8	Clay
30 – 45	8 – 14	7 – 10	Clay
45 – 96	12 – 46	6 – 10	Clay
96 – 107	38 – 61	6 – 10	Clay
107 – 116	26 – 56	7 – 14	Sandy Clay
116 – 127	27 – 53	5 – 11	Clay
127 – 144	12 – 65	6 – 18	Sandy Clay
144 – 200	40 – 65	6 – 10	Clay

144 – 200	40 – 65	6 – 10	Clay

Table 11 Results of logging measurements on SB-KI

Depth (m)	Observation result		Lithology
	SP(mV)	Resistivity (Ohms)	
0 – 3	-	-	Cover Land
3 – 49	-	-	-
49 – 65	248 – 260	5- 11	Clay
65 – 98	250 – 260	6 – 19	Sandy Clay
98 – 110	260 – 282	7 – 12	Clay
110 – 133	248 – 300	5 – 17	Sandy Clay
133 – 152	252 – 265	4 – 9	Clay
152 - 173	220 - 230	8 - 23	Clay Sandstone

3.4 Porosity and Permeability Index Test

Calculation of the value of rock porosity is used to determine how much pore space can be filled by fluid in a rock layer, the higher the porosity value indicates the greater the space that can be filled by the fluid, Based on the classification proposed by Todd, 1980 the porosity value possessed by seven samples can be seen in the table below:

Table 12 Rock Porosity Value

Test Well	Depth (m)	Porosity (%)	Todd's Classification (1980)
SB-HIK	203 – 203.4	19,899	(10% - 20%) Medium
SB-RK	166 – 167	4.7	(1% - 10%) Small
	205 – 205.7	12.3	(10% - 20%) Medium
SB-SMK	151.8 – 151.9	13.65	(10% - 20%) Medium
	165 – 166	8.22	(1% - 10%) Small
	171.85 – 172	2.9	(1% - 10%) Small
	206.4 – 206.6	11.6	(10% - 20%) Medium

Based on the permeability value of the seven samples, the hydraulic conductivity value can be calculated using the equation:

$$\mathbf{K} = \frac{k.\Upsilon\omega}{\mu} \quad \text{.......(1)}$$

Where : K = Hydraulic Conductivity (Cm/S)
K = Intrinsic Permeability (Cm2)
$\Upsilon\omega$ = density of water (g/cm3)
μ = Viscosity (g/cm2)

From the calculation of the hydraulic conductivity values, it can be classified based on the Todd Classification (1980) so that it can be seen that the hydraulic conductivity conditions in the seven samples are almost the same.

Table 13 Rock Permeability Value

Test Well	Depth (m)	Permeability (mD)
SB-HIK	203 – 203.4	314,895
SB-RK	166 – 167	23.31
	205 – 205.7	54.93
SB-SMK	151.8 – 151.9	314.54
	165 – 166	49.8
	171.85 – 172	25,13
	206.4 – 206.6	128.63

Table 14 Rock Hydraulic Conductivity Value

Test Well	Depth (m)	Hydraulic Conductivity (m/day)	Todd's Classification (1980)
SB-HIK	203 – 203.4	0.2304	Medium Categorywith a K value of 4.08 x 10-4 up to 4.08 x 10^{-1} m/day
SB-RK	166 – 167	0.01706	
	205 – 205.7	0.0403	
SB-SMK	151.8 – 151.9	0.2306	
	165 – 166	0.03646	
	171.85 – 172	0.01839	
	206.4 – 206.6	0.09418	

3.5 Lithological Correlation

In determining the stratigraphy of the study area, the data confined from geolsitric measurements and logbor data are then correlated to produce a lithological fence diagram (Figure 8). Based on the fence diagram of the correlation results found in the research area, it can be seen the subsurface lithological conditions.

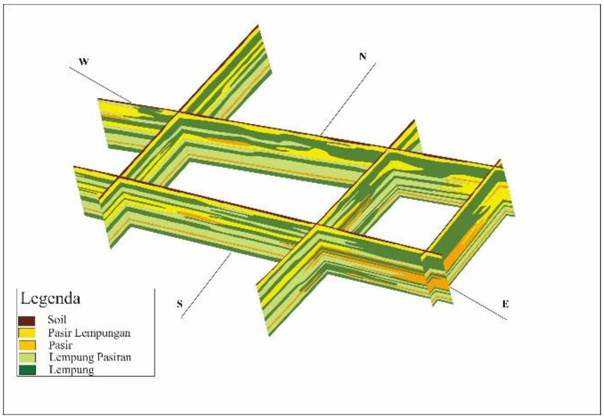

Figure 8. The lithological fence diagram of the study area

4. CONCLUSION

The conclusions confined from this research are:

1) The results of the geoelectrical interpretation show that there is an aquifer carrying layer with loamy sand lithology at the GL-1 point at a depth of 53.65 m - 120.38 m, with a thickness of 66.73 m. The GL-2 point isaquifer layer with clay sand lithology at a depth of 53.91 m - 96 m, a thickness of 42.9 m and sandy clay with a thickness of 123 m at a depth of 97 m - 220 m. The GL-3 point contains an aquifer layer at a depth of 15.21 m - 40.67 m, a thickness of 25.46 m, and sand at a depth of 137.16 m - 166.85 m, with a thickness of 25.69 m. The GL-4 point contains an aquifer layer with clay sand lithology at a depth of 54.75 m - 62.4 m, a thickness of 7.65 m and sandy clay at a depth of 75.2 m – 220.76 m below the surface with a thickness of ±145, 56 meters.
2) The interpretation results of the SB-8 test well indicate the presence of an aquifer layer at a depth of 81.3 m – 187.5 m with sandy-clay lithology, a depth of 187.5 m – 196 m with sandstone lithology, and a depth of 196 m – 210 m. in the form of sandy loam. The test well SB-9 showed the presence of an aquifer layer at a depth of 106 m – 161.8 m with a sandy clay lithology, a depth of 165 m – 172.5 m with a loamy sand lithology, and a depth of204.7m – 207.9m with sandstone lithology. The test well SB-6 showed the presence of an aquifer layer at a depth of 141 m – 155 m and 160 m – 185 m with sandy clay lithology, and a depth of 196 m – 205 m with sandstone lithology. The test well SB-7 showed the presence of an aquifer layer at a depth of 105 m – 133 m and 166 m – 171.5 m with sandy loam lithology.
3) Meanwhile, from the measurement*well electrical logging*at point SB-8, data confined for aquifer layers at a depth of 114 m – 118 m. Point SB-9 contains data on aquifer layers at a depth of 160 m – 163 m, 169 m – 176 m, and 188 m – 210 m. Point SB-1 contains an aquifer layer at a depth of 98 m – 103 m, 116 – 122 m, and 127 m – 140 m. Point SB-4 contains an aquifer layer at a depth of107 m – 116 m and 127 m – 144 m. Point SB-6 contains an aquifer layer at a depth of65 m – 98 m, 110 m – 133 m, and 152 – 173 m.
4) Based on the porosity index test, it is known that the aquifer layer that has moderate porosity values is at point SB-5 with a depth of 203 m, point SB-7 with a depth of 205 m, and point SB-8 at a depth of 151 m and 206 m. While the value of hydraulic conductivity in the seven samples has a value that is almost the same as the medium category.
5) The results of this investigation generally indicate that there is potential for aquifers in the study area at a depth of more than 150 masl with porosity and permeability values that have moderate to good values so that they can be used as alternatives to meet their raw water needs.

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