Science World Journal Vol. 20(No 4) 2025 https://dx.doi.org/10.4314/swj.v20i4.18
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Full Length Research Article

EVALUATION OF AQUIFER PARAMETERS WITHIN LOKOJA, NORTH CENTRAL NIGERIA

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ABSTRACT
Groundwater is the most important source of water for domestic and commercial purposes. With an increase in rural-urban migration, access to potable water supply has decreased drastically, and available groundwater supply within the study area has also been affected by perennial low yield. Therefore, this work was targeted at evaluating the aquifer parameters of the study area using pumping test data. Constant rate pumping test with a single well was carried out in seven boreholes at selected locations in which the aquifers within the study area are unconfined. The static water level ranged from 4.5-16.7 m with a mean value of 8 m, while borehole depths ranged from 55- 70 m or an average borehole depth of 63 m. The yield of the boreholes is in the range of 48.9 to 115.9 m³/day. The hydraulic conductivity ranged from 6.48×10^-7 to 2.1×10^-5 m/s with an average of 6.12×10^-6 m/s. The computed values of transmissivity ranged from 1.29×10^-3 - 3.57×10^-3 m²/s, and the specific capacity of the tested well ranged from 9.59×10^3 -1.96×10^-3 m^2/s. These results show that the aquifers within the study area can provide between 5000 to 40,000 liters of water per day based on the aquifer transmissivity. The aquifers can therefore serve as sustainable and dependable sources of water all year round, with sufficient water to meet the domestic needs if properly developed. It is suggested that a similar study should be carried out with the presence of two or more observations well within the study area so as to aid regional planning and management of groundwater resources.

Keywords: Aquifer, Hydraulic Conductivity, Transmissivity, Specific Capacity, Groundwater

INTRODUCTION

Aquifer parameters that can be derived from a pumping test include transmissivity, hydraulic conductivity, specific capacity of the well, and so on. The transmissivity of an aquifer is explained as the rate at which water flows through the aquifer under a unit width and a unit hydraulic gradient. It is obtained by multiplying the aquifer's hydraulic conductivity by the aquifer thickness. The higher the value of the transmissivity, the more productive the aquifer and the smaller the value of the drawdown from the well. Conversely, this means that a lower transmissivity value leads to less productivity and greater drawdown. The hydraulic conductivity of an aquifer is described as the rate at which water flows in the aquifer. It is measured in cubic meters per day (Anomohanran, 2014). The specific capacity of a drilled well is the rate at which water is pumped out of the well divided by the fall in water level. It is a very valuable number that can be used to determine the pumping rate or the maximum yield for a well. The specific capacity is a measure of the productivity of a well, and it is a fact that the larger the specific capacity, the better the well (Lee *et al.* 2017, Sanka & Muhammad, 2019). The evaluation of aquifer parameters within the study area has been studied by few authors. Some of them include: Olabode *et al* (2012) analyzed meteorological, drilling, pumping tests, and quality data. The results showed that transmissivity values varied between 1.367 to 393 m^2/day. Also, Sule *et al* (2017) worked on the Sustainability of Groundwater for Domestic Uses in Kogi State via pump testing analysis and determined the hydraulic parameters of the aquifers within the study area. The results showed that the value of hydraulic conductivity is 0.208 m/day, and transmissivity 6.57m^2 /day, and the aquifers within Kogi State can provide between 5000 to 40,000 litres of water per day. Furthermore, Olusegun *et al* (2018) evaluated aquifer hydraulic characteristics of Lokoja using geoelectrical sounding, pumping, and laboratory tests, and their findings indicated that the hydraulic conductivity of Lokoja Formation and Patti Formation is in the range of permeable to high.

However, to contribute to the improvement and development of groundwater, this study is based on evaluation of aquifer parameters by conducting pumping tests on boreholes and analysis of the pumping test data to determine the transmissivity(T), hydraulic conductivity(K) and specific capacity (Sc) of the aquifer within Federal University Lokoja (FUL) Adankolo Campus and environs part of sheet 247 Lokoja, north-central Nigeria.

Location and Geology of the Study Area

The study area falls within the FUL Adankolo Campus and environs part of Sheet 247 Lokoja Northwest (NW). It is bounded by latitude $007^0$46'45.6'' to $007^0$53'21.0''and longitude $06^0$40'0.0'' to $06^0$45'0.0'' of meridian respectively. A network of all-season roads that connects the main parts of Lokoja makes the area accessible, and the rivers can be crossed by boats and ferries. The total areas extend approximately 112km^2 on a scale of 1:25,000. The various locations within the study area are mostly accessible by the main road, minor roads and foot paths, and these are utilized during the work (see figure 1).

The study area lies within the crystalline (Basement) Complex and Sedimentary Basins of Nigeria. Lokoja is located at the confluence of the Niger and Benue Rivers and at the contact between the Precambrian Basement Complex of Nigeria, the Campanian-Maastrichian sedimentary Bida Basin (Omada *et al*., 2009), and the Lower Benue sedimentary inland basin (Benue Trough). The geology comprises the Precambrian Basement Complex rocks, which are mostly gneiss and migmatite with older granitic intrusives. The mineral foliations defined by alternating biotite-rich and quartz-feldspar-rich rich are common in the gneiss. Major foliation and fracture trends are in the N-S and NNE, SSW directions, markedly exhibited by the flow direction of the River Niger (Obaje, 2011).

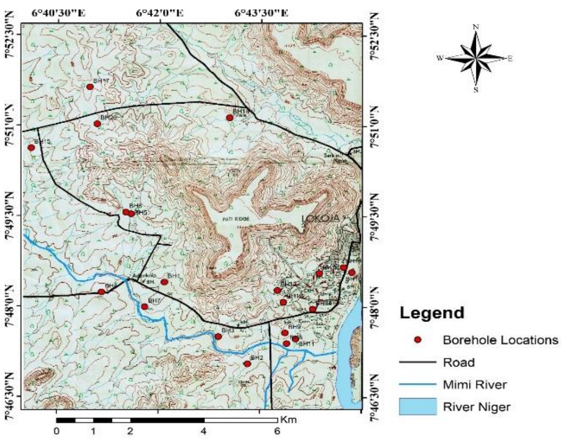

Figure 1: Location Map of the Study Area

MATERIALS AND METHODS

In this study, a total of seven boreholes were pump tested using the constant-rate pumping test method adopted in a single well. At each location, the borehole was opened to an appropriate setting, and static water is first taken using a dipper. Followed by setting up the equipment, which includes, connection of the flow meter to the rising main or pipes and the discharge pipes to the water meter. The recording book was tabulated to include a column of time in minutes, volume of water discharged in litres, water level, and drawdown in meters. The pump was switched on, starting the stopwatch at the same time. The water discharged in litres per second was noted on the flow meter. The water level in the borehole was measured every 2 minutes for the first 20 minutes, then every 5 minutes until 40 minutes had elapsed, then every 10 minutes until 1 hour had elapsed. After 1 hour, how quickly the water level is still falling was observed, and an appropriate frequency for water-level readings was decided until the end of the test.

The change in water level is measured using the electric water indicator at regular time intervals. The time, volume, static water level, and discharge are recorded in a tabulated pumping test data sheet.

Data analysis

Cooper and Jacob's 1946 solution method was employed for the determination of the aquifer-derived parameters (transmissivity and specific capacity) as shown in Table 8. The slope was obtained by plotting drawdown and its corresponding time data acquired during the pumping test on semi-log format, as shown in Figure 2-8. The time in minutes was plotted along the logarithmic x-axis, while the drawdown was plotted along the y-axis, and Jacob's straight line was fitted through the middle and/or later points, ignoring the early points because they seem to be affected by the volume of water stored in the borehole itself. The thickness of the aquifer (D) was determined from data gathered during a geophysical survey (Vertical Electrical Sounding) performed at each borehole site. The apparent resistivity varies between 120 - 450Ωm average. The pumping rate (Q) in meter cube per day (m^3/day) for the duration of the test and the slope {which is the change in drawdown over one logarithmic cycle(Δs)} were determined and then incorporated into Cooper and Jacob well flow equation (for single well)} as stated below for the for the computation of the transmissivity (T) and specific capacity (Sc):

$$T = (2.303Q) / (4\pi\Delta s) \quad (1)$$
$$K = (2.303Q) / (4\pi D\Delta s) = T / D \quad (2)$$
$$Sc = Q / \Delta s \quad (3)$$

Where T is the transmissivity measured in meter square per day, K is the Hydraulic conductivity measured in meter per second, Q is the discharged rate measured in meter cube per day, ΔS is the slope of drawdown versus log of time (change in drawdown per logarithmic cycle), and Sc is the specific capacity measured in meter square per day.

RESULTS AND DISCUSSION

A total of seven (7) pumping test was carried out on boreholes within the study area. The tables presented below show the time at which water is being pumped from the borehole, the dynamic water level, and the drawdown obtained by subtraction of the static water level from the water level.

Table 1: Pumping Test Data for BH8 (N 7°47'23.6'' E6°43'53.9'')

S/N	Time(min)	Time(sec.)	Water level (m)	Drawdown (m)
1.	2	120	7.5	1.5
2.	4	240	8.7	2.7
3.	6	360	9.6	3.6
4.	8	480	10.4	4.4
5.	10	600	11.3	5.3
6.	12	720	12.1	6.1
7.	14	840	12.8	6.8
8.	16	960	13.4	7.4
9.	18	1080	14.0	8.0
10.	20	1200	14.6	8.6
11.	25	1500	16.0	10.0
12.	30	1800	17.3	11.3
13.	35	2100	18.5	12.5
14.	40	2400	19.4	13.4
15.	45	2700	20.4	14.4
16.	50	3000	21.3	15.3
17.	55	3300	22.1	16.1
18.	60	3600	22.9	16.9
19.	70	4200	24.5	18.5
20.	80	4800	25.6	19.6

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21.	90	5400	26.0	20.0
22.	100	6000	26.5	20.4

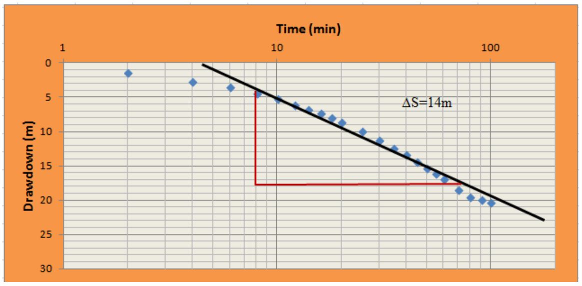

Figure 2: Plot of drawdown versus time for BH8

Table 2: Pumping Test Data for BH9 (N7°47'34.2'' E6°43'52.4'')

S/N	Time(min)	Time(sec.)	Water level (m)	Drawdown (m)
1.	2	120	5.2	0.52
2.	4	240	7.04	2.36
3.	6	360	7.58	2.9
4.	8	480	8.16	3.48
5.	10	600	8.66	3.98
6.	12	720	8.89	4.21
7.	14	840	9.2	4.52
8.	16	960	9.55	4.87
9.	18	1080	9.84	5.16
10.	20	1200	10.12	5.44
11.	25	1500	10.77	6.09
12.	30	1800	11.38	6.70
13.	35	2100	11.91	7.23
14.	40	2400	12.40	7.72
15.	45	2700	12.86	8.18
16.	50	3000	13.30	8.62
17.	55	3300	13.75	9.07
18.	60	3600	14.09	9.41
19.	70	4200	14.8	10.12
20.	80	4800	15.50	10.82

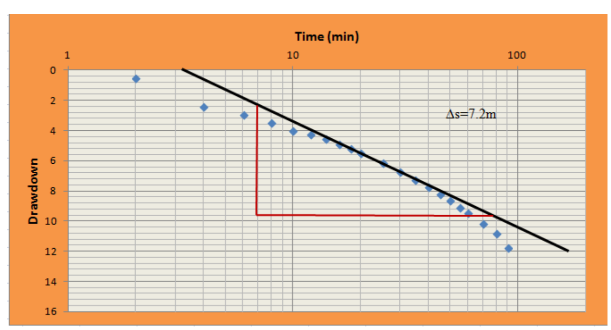

Figure 3: Plot of drawdown versus time for BH9

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Table 3: Pumping Test Data for BH10 (N7°47'18.2" E6°48'51.6")

S/N	Time(min)	Time(sec.)	Water level (m)	Drawdown (m)
1.	2	120	5.75	0.30
2.	4	240	5.93	0.48
3.	6	360	6.01	0.56
4.	8	480	6.14	0.69
5.	10	600	6.15	0.70
6.	12	720	6.15	0.70
7.	14	840	6.15	0.70
8.	16	960	6.18	0.73
9.	18	1080	6.20	0.75
10.	20	1200	6.20	0.75
11.	25	1500	6.25	0.80
12.	30	1800	6.25	0.80
13.	35	2100	6.31	0.86
14.	40	2400	6.31	0.90
15.	45	2700	6.31	0.94
16.	50	3000	6.31	0.96

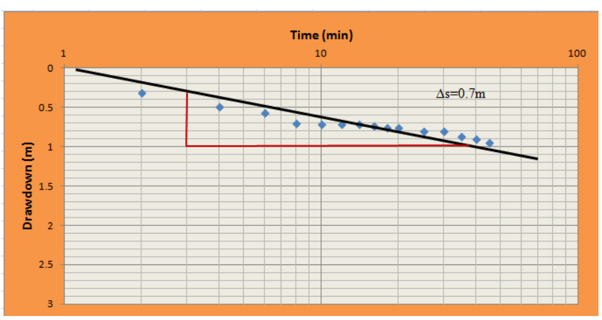

Figure 4: Plot of drawdown versus time for BH10

Table 4: Pumping Test Data for BH11 (N7°47'28.2" E6°44'1.8")

S/N	Time(min)	Time(sec.)	Water level (m)	Drawdown (m)
1.	2	120	6.33	1.83
2.	4	240	6.57	2.07
3.	6	360	6.58	2.08
4.	8	480	6.58	2.08
5.	10	600	6.61	2.11
6.	15	900	6.64	2.14
7.	20	1200	6.66	2.16
8.	25	1500	6.69	2.19
9.	30	1800	6.70	2.20
10.	35	2100	6.71	2.21
11.	40	2400	6.72	2.22
12.	45	2700	6.74	2.24
13.	50	3000	6.74	2.24
14.	55	3300	6.77	2.27
15.	60	3600	6.77	2.27
16.	65	3900	6.77	2.27

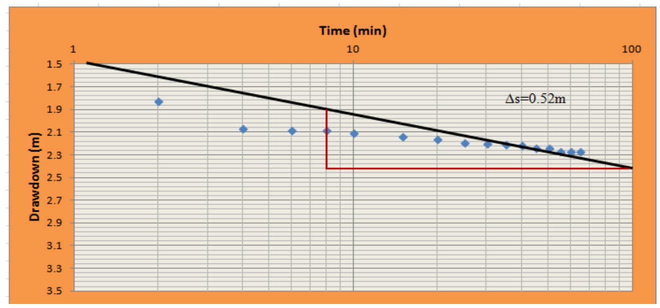

Figure 5: Plot of drawdown versus time for BH11

Table 5: Pumping Test Data for BH12 (N7°48'4.8" E6°43'50.9")

S/N	Time(min)	Time(sec.)	Water level (m)	Drawdown (m)
1.	2	120	15.18	2.58
2.	4	240	15.70	3.10
3.	6	360	16.09	3.49
4.	8	480	16.40	3.80
5.	10	600	16.66	4.06
6.	12	720	16.85	4.25
7.	14	840	17.00	4.40
8.	16	960	17.12	4.52
9.	18	1080	17.23	4.63
10	20	1200	17.35	4.75
11	25	1500	17.64	5.04
12	30	1800	17.83	5.23
13	35	2100	18.05	5.45
14	40	2400	18.24	5.64

15	45	2700	18.49	5.89
16	50	3000	18.73	6.13
17	55	3300	19	6.40
18	60	3600	19.2	6.60
19	70	4200	19.44	6.84
20	80	4800	19.67	7.07
21	90	5400	20.02	7.72

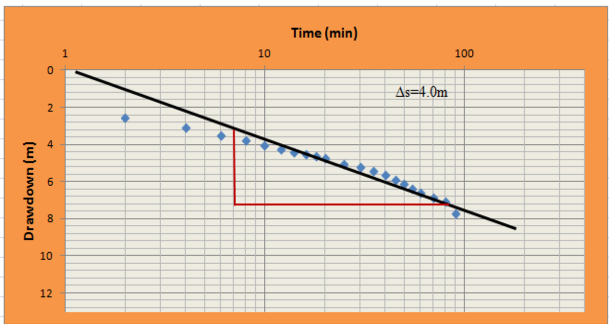

Figure 6: Plot of drawdown versus time for BH12

Table 6: Pumping Test Data for BH13 (N7°48'16.5" E6°43'45.5")

S/N	Time(min)	Time(sec.)	Water level (m)	Drawdown (m)
1.	2	120	18.10	1.39
2.	4	240	18.60	1.89
3.	6	360	19.05	2.34
4.	8	480	19.42	2.71
5.	10	600	19.75	3.04
6.	12	720	20.05	3.34
7.	14	840	20.33	3.62
8.	16	960	20.63	3.91
9.	18	1080	20.87	4.16
10.	20	1200	21.16	4.45
11.	25	1500	21.74	5.03
12.	30	1800	22.30	5.59
13.	35	2100	22.78	6.07
14.	40	2400	23.27	6.56
15.	45	2700	23.72	7.01
16.	50	3000	24.10	7.39
17.	55	3300	24.53	7.82
18.	60	3600	24.90	8.19
19.	70	4200	25.60	8.89
20.	80	4800	26.24	9.53
21.	90	5400	26.86	10.15

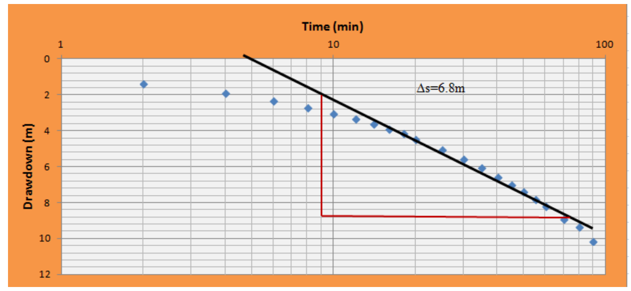

Figure 7: Plot of drawdown versus time for BH13

Table 7: Pumping Test Data for BH14 (N7°47'57.9" E6°44'16.7")

S/N	Time(min)	Time(sec.)	Water level (m)	Drawdown (m)
1.	2	120	8.07	1.01
2.	4	240	9.15	2.09
3.	6	360	10.09	3.03
4.	8	480	12.95	5.89
5.	10	600	13.47	6.41
6.	12	720	13.78	6.72
7.	14	840	14.00	6.94
8.	16	960	14.26	7.20
9.	18	1080	14.59	7.53
10.	20	1200	14.87	7.81
11.	25	1500	15.54	8.48
12.	30	1800	15.88	8.82
13.	35	2100	16.05	8.99
14.	40	2400	16.3	9.24
15.	45	2700	16.57	9.51
16.	50	3000	16.89	9.83
17.	55	3300	17.06	10.00
18.	60	3600	17.30	10.24
19.	70	4200	17.84	10.78
20.	80	4800	18.07	11.01
21.	90	5400	18.32	11.26

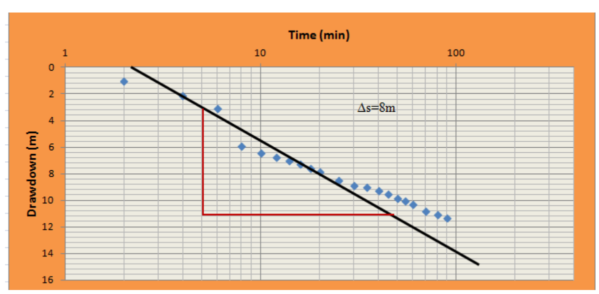

Figure 8: Plot of drawdown versus time for BH14

From table 1-7 and figure 1-8 presented above, the summary of the computed transmissivity, hydraulic conductivity and specific capacity are presented in table 8 below.

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www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
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Table 8: The Summary of pumping test data and computed specific capacity, hydraulic conductivity and transmissivity values.

S/N	Well name	Coordinates	Borehole depth (m)	Static water level (m)	Q (L/sec)	ΔS (m)	D (m)	T (m^2/sec.)	K (m/sec.)	Sc (m^2/sec.)
1.	BH8	N7°47'23.6" E6°43'53.9"	55	6	1.34	14	24	1.76×10^{-5}	7.33×10^{-7}	9.59×10^{-5}
2.	BH9	N7°47'34.2" E6°43'52.4"	65	4.68	0.92	7.2	26	2.33×10^{-5}	8.97×10^{-7}	1.27×10^{-4}
3.	BH10	N7°47'18.2" E6°48'51.6"	60	5.45	1.20	0.7	15	3.10×10^{-4}	2.10×10^{-5}	1.72×10^{-3}
4.	BH11	N7°47'28.2" E6°44'1.8"	65	4.5	1.02	0.52	22	3.57×10^{-4}	1.63×10^{-5}	1.96×10^{-3}
5.	BH12	N7°48'4.8" E6°43'50.9"	60	12.6	0.88	4	20	4.02×10^{-5}	2.01×10^{-6}	2.19×10^{-4}
6.	BH13	N7°48'16.5" E6°43'45.5"	65	16.71	1.00	6.8	23	2.69×10^{-5}	1.17×10^{-6}	1.47×10^{-4}
7.	BH14	N7°47'57.9" E6°44'16.7"	70	7.06	0.57	8	20	1.29×10^{-7}	6.48×10^{-7}	7.09×10^{-5}
8.		Minimum	55	4.5	0.57	0.52	25	1.29×10^{-7}	6.48×10^{-7}	7.09×10^{-5}
9.		Maximum	70	16.71	1.34	14	10	3.57×10^{-4}	1.20×10^{-3}	1.96×10^{-3}
10.		Mean	62.857	8.143	1.00	5.889	18.28	1.13×10^{-4}	6.12×10^{-6}	6.19×10^{-4}

DISCUSSION

The pumping test result (Table 1 – 7), calculated hydraulic conductivity, transmissivity, and specific capacity results are presented in Table 8. The hydraulic conductivity (K) values of auriferous units of the selected boreholes ranged from 6.48×10^{-7} to 2.1×10^{-5} m/s with an average of 6.12×10^{-6} m/s. Based on the hydraulic conductivity classification scheme (see Table 10), which has been used by several authors such as Miranda *et al.* (2025), Safari *et al.* (2025), Amakiri *et al.* (2024), the hydraulic conductivities obtained in the study area ranged from Low to Moderate. BH10 and BH11 are permeable, having the highest hydraulic conductivity value of 2.1×10^{-5} m/s and1.63×10^{-5}m/s respectively.

The yield of the boreholes was interpreted based on Akinwumiju *et al.* (2016) scheme (see Table 9), and the values ranged from 0.57 l/s to 1.34 l/s with an average of 1.43 l/s, which was in agreement with the value (1.33 l/s) obtained by Sule BF *et al.* (2013) carried out in Lokoja. It was observed that 57% of the tested wells have a Moderate yield and can supply a reasonable amount of water, that is, 1 liter per second. This includes BH8, BH10, B11, and BH13 with 1.34, 1.20, 1.02, and 1.0 l/s, respectively. Whereas, 43% of the boreholes have a Low yield of 0.92, 0.88, and 0.57 l/s observed at BH9, BH12, and BH14, respectively. Borehole depths ranged from 55-70 m with an average borehole depth of 63 m. A steady state flow was observed at BH10 in which there was no change between discharge and drawdown, indicating the well is at equilibrium.

The computed values of transmissivity ranged from 1.29×10^{-3} – 3.57×10^{-4} m^2/s with an average transmissivity of 1.13×10^{-4} m^2/s. Also, an aquifer with transmissivity values ranging from 1.157×10^{-5} – 1.157×10^{-4} m^2/s would be capable of yielding around 5,000 – 40,000 liters per day which is sufficient for domestic uses in small communities. Prior to the pumping test, data collected based on the transmissivity of the aquifers it can be inferred that the wells are satisfactory for their intended use.

Table 9: Borehole Yield Ranges according to Akinwumiju *et al.* (2016)

Class	Class interval	Groundwater Potential
1	0.0 – 0.5	Very Low
2	0.5 – 1.0	Low
3	1.0 – 1.5	Moderate
4	1.5 – 2.5	High
5	>2.5	Very High

Table 10: Hydraulic conductivity classification

Class	Class interval	Groundwater Potential
1	$1 – 10^{-2}$	Very High
2	$10^{-2} – 10^{-4}$	High
3	$10^{-4} – 10^{-7}$	Moderate
4	$10^{-7} – 10^{-10}$	Low
5	$10^{-10} – 10^{-13}$	Very Low

Table 11: Classification of Transmissivity Magnitude (Krasny, 1993).

Magnitude of Transmissivity (m^2/s)	Class	Designation	Specific Capacity (m^2/s)	Groundwater Supply Potential
$>1.2\times10^{-2}$	I	Very high	$>1.04\times10^{-2}$	Regional importance
1.2×10^{-3} – 1.2×10^{-2}	II	High	1.04×10^{-3}– 1.04×10^{-2}	Lesser regional importance
1.2×10^{-4} – 1.2×10^{-3}	III	Intermediate	1.04×10^{-4}– 1.04×10^{-3}	Local water supply
1.2×10^{-5}– 1.2×10^{-4}	IV	Low	1.04×10^{-5}– 1.04×10^{-4}	Private consumption
1.2×10^{-6}– 1.2×10^{-5}	V	Very low	1.04×10^{-6}– 1.04×10^{-5}	Limited consumption
$<1.2\times10^{-6}$	VI	Imperceptible	$<1.04\times10^{-6}$	Very difficult to utilize for the local water supply

Based on the classification and potentiality scheme proposed by Kransy (1993), as shown in (Table 11) above, it can be deduced that areas of low, moderate, and high aquifer potential can be targets for groundwater exploration depending on the scale/magnitude of the intended purpose. The transmissivity value of the study area shows low to moderate aquifer potential as seen in Table 12, with BH10 and BH11 having the highest transmissivity values. The results correlate with some authors' work, like Nzouemou *et al*. (2025), Ejepu *et al.* (2024), Abdullahi *et al*. (2014 and Udeh *et al.* (2025), who recently used the Kransy classification.

Hence, the specific capacity of the tested well ranged from 9.59×10^{-5} – 1.96×10^{-3} m^2/s (see Table 12), which shows low to high specific capacity and has groundwater supply potential for private consumption to lesser regional importance based on Kransy (1993) classification. BH10 and BH11 have the highest specific capacity 1.72×10^{-3} and 1.96×10^{-3} m^2/s, respectively, meaning that they can be of regional use. However, from the evaluated aquifer parameters, the tested boreholes are prolific for groundwater exploration.

Tables 12: Summary of Aquifer Parameters, interpretation of the Study Area

BH No.	Yield (l/s)	Designation	K(m/s)	Designation	T (m^2/s)	Designation	Sc (m^2/s)	Designation
BH8	1.34	Moderate	7.33×10^{-7}	Low	1.76×10^{-5}	Low	9.59×10^{-5}	Local water supply
BH9	0.92	Low	8.97×10^{-7}	Moderate	2.33×10^{-5}	Low	1.27×10^{-4}	Local water supply
BH10	1.20	Moderate	2.10×10^{-5}	Moderate	3.10×10^{-4}	Intermediate	1.72×10^{-3}	Lesser regional importance
BH11	1.02	Moderate	1.63×10^{-5}	Moderate	3.57×10^{-4}	Intermediate	1.96×10^{-3}	Lesser regional importance
BH12	0.88	Low	2.01×10^{-6}	Moderate	4.02×10^{-5}	Low	2.19×10^{-4}	Local water supply
BH13	1.00	Moderate	1.17×10^{-6}	Moderate	2.69×10^{-5}	Low	1.47×10^{-4}	Local water supply
BH14	0.57	Low	6.48×10^{-7}	Low	1.29×10^{-7}	Low	7.09×10^{-5}	Local water supply

https://dx.doi.org/10.4314/swj.v20i4.18

Conclusion

The hydraulic parameters of aquifers in selected wells in the study area have been determined by the analysis of available pumping test data. 57% of the boreholes show moderate pumping rate and can yield 1 litre of water per second, while 43% show a low pumping rate producing about 0.7 l/s. The aquifers within the study area have been shown (based on transmissivity values) to be capable of serving as sustainable water sources for domestic uses. Places like BH10, BH11 have high groundwater supply yield and are suitable to a site community water scheme due to their high transmissivity values. In addition, places like BH8, BH9, BH13, and BH14 with low transmissivity have groundwater supply yield for private consumption. The hydraulic conductivity (K) values of aquiferous units of the selected boreholes ranged from 6.48×10^{-7} to 2.1×10^{-5} m/s with an average of 6.12×10^{-6} m/s, indicating low to intermediate permeability. The aquiferous units are capable of yielding optimum groundwater for private consumption and partly to small communities, and to some extent can supply water for large-scale regional use.

Based on the above results, it is recommended that areas of moderate and high aquifer potential should be the target for groundwater exploration, depending on the scale/magnitude of the designated purpose. It is also suggested that further field hydrogeological surveys should be conducted to better infer the hydraulic features of these aquifers. Finally, similar studies should be carried out with two or more observations well in place to aid regional planning and management of groundwater resources.

REFERENCES

Abdullahi, N. K., Udensi, E. E., Iheakanwa, A., & Eletta, B. E. (2014). Geoelectrical method applied to evaluation of groundwater potential and aquifer protective capacity of overburden units. *British Journal of Applied Science & Technology,* 4(*14*), 2024–2037.

Akinwumiju A.S, Olorunfemi, M.O., and Afolabi, O. (2016). GIS-Based Integrated Groundwater potential assessment of Osun drainage Basin, Southwestern Nigeria. Ife *Journal of Science* vol. 18, (*1*)163

Amakiri, A. R. C., Okorobia, E., Amonieah, J., Otugo, V. N. (2024). Application of VES and Physicochemical Analysis for the Evaluation of Dissolved Minerals in the Alluvial Aquifers of Part of Yenagoa, Bayelsa State. *International Journal of Energy and Environmental Science*, 9(5), 107-122.

Anomohanran, O. (2014b). Hydrogeophysical and hydrogeological investigations of groundwater resources in Delta Central, Nigeria. *Journal of Taibah University for Science*, 9(2015), 57–68.

Cooper. H. H. and Jacob, C. E., (1946). A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well-Field History, Trans. A. G. U., Vol. 27. Pp. 526-534.

Ejepu, J.S., Jimoh, M.O., Abdullahi, S. et al. (2024). Geoelectric analysis for groundwater potential assessment and aquifer protection in a part of Shango, North-Central Nigeria. *Discovery Water* 4, 33.

Krasny, J., (1993). Classification of Transmissivity Magnitude and Variation. *Groundwater* 31(*2*), 230-236.

Lee, S., Hong, S. M., & Jung, H. S. (2017). GIS-based groundwater potential mapping using artificial neural network and support vector machine models: the case of Boryeong city in Korea. *Geocarto International,* 33(*8*), 847–861.

Miranda, M.M., Raymond, J., Dezayes, C. et al. (2025). Estimating the permeability of crystalline rocks from geological data in remote northern environments: advantages and limitations. *Hydrogeology Journal 33,* 115–129.

Nzouemou, F., Dongmo, N.G.T., Tabod, T.C. et al. (2025). Geoelectrical assessment of groundwater potential and aquifer characteristics in the west region of Cameroon. Journal of Advances in Modeling Earth Systems *and Environment.* 11, 7.

Obaje, N.G., Moumouni, A., Goki, N.G. and Chaanda, M.S. (2011). Stratigraphy, paleogeography, and hydrocarbon resource potentials of the Bida Basin in North-Central Nigeria. *Journal of Mining and Geology*, 47(2), 97–114.

Olabode, O. T., Eduvie, O. M., and Olaniyan, O. I. (2012). Evaluation of Groundwater Resources of the Middle Niger (Bida) Basin of Nigeria. *American Journal of Environmental Engineering,* 2(*6*), 166-173.

Olusegun Omoniyi Ige, Daniel Opemipo Obasaju, Christopher Baiyegunhi, Olufemi Ogunsanwo, and Temitope Baiyegunhi (2018). Evaluation of aquifer hydraulic characteristics using geoelectrical sounding, pumping, and laboratory tests: A case study of Lokoja and Patti Formations, Southern Bida Basin, Nigeria. *Open Geoscience* 10(*1*) 807–820.

Omada JI, Omali A, Awodi JO. (2009). Physicochemical characteristics of surface water in parts of Lokoja Metropolis, Central Nigeria. Water resources. *Journal of the Nigerian Association of Hydrogeologists* 19: 56-62.

Safari, M., Doulati Ardejani, F., Maghsoudy, S. et al. (2025). Estimating Hydraulic Conductivity in Fractured Rocks Using Factorial Design and Borehole Imaging. *Geotechnical and Geological Engineering 43*, 116.

Sangka Aryawicaksona and Muhammad A.S. (2019). Application of Specific Capacity In Monitoring Groundwater Well : A Case Study of Kota Agung Groundwater Well. *Journal of Physics: Conference Series.* 1363 .

Sule and Ayenigba (2017). Sustainability of Groundwater for Domestic Uses in Rural Communities of Kogi State, Nigeria. *Saudi Journal of Engineering and Technology,* 2(*9*),324-334.

Sule, B. F., Balogun, O. S., & Muraina, L. B. (2013). Determination of hydraulic characteristics of groundwater aquifer in Ilorin, North Central Nigeria. *Scientific Research and Essays,* 8(*25*), 1150-1161.

Udeh, H.M., Opara, A.I., Akakuru, O.C. et al. (2025). Aquifer geo-hydraulic characteristics of Enugu and environs, southeastern Nigeria, using pumping test and geo-sounding data. *International Journal of Energy Water Resources 9,* 917–940.