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HYDRAULIC EVALUATIONS OF AQUIFER YIELDS IN RESIDENTIAL COMMUNITY OF EWEKORO, SOUTH-WEST NIGERIA

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ABSTRACT

Groundwater serves as supplements to the surface water supply in Ewekoro area of Ogun State because of the output of the public surface water supply system in the area which cannot sustain the needs of the teeming populace of the Ewekoro residence. Pumping tests were conducted on twenty five (25) selected boreholes and twenty five (25) hand-dug wells within Ewekoro area to ascertain the yield of these water sources. Constant rate pumping test for boreholes and recovery method test for hand-dug wells were carried out in residential community of Ewekoro, South-West Nigeria. It was revealed that discharge is directly proportional to the yield of the boreholes and hand-dug wells at a constant drawdown; hence the discharge rate determines the yield of each of the selected boreholes. The average depth of the existing boreholes were found to be 60.32m higher than the depth of hand-dug wells whose average depth was found to be 8.28m in the investigated area. The borehole discharges ranged from 3.0×10^{-2}l/s to 6.0×10^{-2} l/s with an average discharge of 4.0×10^{-2} l/s while the discharges from the hand-dug wells ranged from 1.0×10^{-2} l/s to 6.0×10^{-2} l/s with an average discharge of 2.0×10^{-2} l/s. Transmissibility ranged from 8.64 to 6912 m^2/day with an average value of 777.6 m^2/day and from 8.64 to 35,424 m^2/day with an average value of 7344 m^2/day respectively for boreholes and hand-dug wells. Average residual drawdown of 7.48m, average Static Water Level of 22.1m within a range of 4.41m to 48.1m, average Specific Capacity and Well Loss Constant were 6.0×10^{-3} m^2/s and 0.616×10^{4} s^2/m^5 respectively with maximum Transmissibility of 8.0×10^{-2} m^2/s (6912 m^2/day) were recorded for Ewekoro boreholes while the average residual drawdown of 0.93m, average Static Water Level of 2.04m within a range of 0.64m to 4.94m, mean Specific Capacity and Well Loss Constant (WLC) of 6.2×10^{-2} m^2/s and 1.247×10^{4} s^2/m^5 respectively with maximum Transmissibility of 4.1×10^{-1} m^2/s (35,424 m^2/day) were recorded for Ewekoro hand-dug wells. The average recovery period of 2483 seconds and 7961 seconds were respectively recorded for Ewekoro boreholes and hand-dug wells. Results from the two water sources in this study, most specifically the transmissibility revealed that investigated aquifer in the study area possesses high groundwater potentials (>500 m^2/day) based on standard aquifer potentiality classification and the possibility of exploiting even the shallow aquifers for domestic uses as well as small-scale purposes where the demand for continuous use of public surface water supply is not met. Ewekoro Groundwater yield ranged between 2.86×10^{-2} l/s and 5.747×10^{-2} l/s in Boreholes and 5.721×10^{-3} l/s and 60.976×10^{-3} l/s in hand-dug wells with coefficient of variation greater than 10%. The yield was not totally dependent on the depths, but also on such parameters as porosity and permeability. Therefore, this implies that the variation exhibited in the hydraulic parameters is high enough to be significant in hydrogeological system of Ewekoro water sources with high prospectivity of meeting the current and future needs of the increasing population in the study area.

Keywords: Yield, Cone of Depression, Hand-Dug Wells, Drawdown, Ewekoro.

INTRODUCTION

The significance of qualitative and quantitative water supply in any society; urban or rural area cannot be overemphasized. Water constitutes about 70% of the earth's surface and has the ability to exist in three states of matter; as solid, liquid and gas (Anomohanran, 2011). The volume of earth's water is estimated at about 1304 million cubic kilometers (Ale *et al.*, 2015). Out of which 1268 million cubic kilometers or 97% is contained in the oceans with 50 cubic kilometers of salt water, while 2.5% or 32million cubic kilometers form the world's total supply of fresh water, while the remaining 4 cubic kilometers is underground (Aribisala, 2010b). Groundwater is a reliable source of water. It is found beneath the earth's surface as a body of water which is trapped in the pore spaces of permeable rock (Anomohanran, 2013). Groundwater is found in the pore spaces between the solid rock and solid rock particles. In unconsolidated and poorly consolidated sediments the pore spaces are simply the openings between the grains. Some rocks have essentially no such pore spaces, but instead may be fractured or dissolved for several reasons. Examples of rocks with "fracture" permeability are hard solid rocks in a fault zone, basalt flows fractured during the cooling process and limestone fractured further dissolved by groundwater (Gbuyiro *et al.,* 2002; Arora, 2024). Ancient metamorphic rocks tend to consist of fine crystalline materials which weather easily to clay near the surface and which often do not contain open fractures. Coarse granite however has the useful property of fracturing within 90m of the earth surface and these fractures can hold groundwater. Removal of the overlying rock eventually results in reduced pressure due to load release fracture from the great internal crystal pressures when the crystal was formed at great depth. (NYSDOH, 2007). The localization of groundwater in fractured zone and weathered zone will make the yield of wells in crystalline bedrock terrain to be highly variable (Anomohanran, 2011). According to Egbai (2011), groundwater is the water that fully saturates pores or cracks in soils and rocks. The volume of groundwater extracted by gravity drainage from saturated water bearing material is referred to as the yield. Water is usually found to exist in different forms at different depths below the surface of the earth toward its centre, (Omosuyi, 2010). Anomohanran (2011) reported that the volume of water available at different depths would depend on the zone of rock fracture. He further mentioned that in this zone, the stresses are within the elastic limits and there exist interstices. Water is stored in the voids; hence the amount of water would depend upon the porosity. It was further mentioned that the maximum depth of this zone below the ground surface ranges between 100m or less and 1,000 m or more. Nwankwo (2011) asserted that in crystalline rocks, most of the water is met within 100m of the surface, while in sedimentary rocks, water is found up to a depth of 1,800m; although, lesser quantity of water is found below 1000m. Therefore, before embarking on groundwater exploration, information on the zone of rock fracture is normally gotten through geophysical survey. The information on the rock fracture would determine the depth at which a productive aquifer could be located. According to Oladapo and Akintorinwa (2007), an aquifer is a formation or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells. Aquifer may be a layer of gravel or sand, sandstone, limestone, lava flow or fractured granite. The major productive aquifers in the world are unconsolidated sand and gravel, limestone, dolomite, basalt and sandstone. Egbai (2011) submitted that the location and yield of aquifer are dependent on geologic conditions; such as the size and sorting of grains in unconsolidated deposits and faulting, solution openings and fracturing in consolidated rocks (limestone, granite, lava, volcanic ash). It is a reasonably defensible statement that the yield of an individual well in consolidated rocks cannot be predicted accurately (Ale *et al.,* 2015). However, the average yield to be obtained from a group of wells can be estimated reasonably well where sufficient data on existing wells are at hand. The adequacy of the estimate will depend largely on the completeness of data available and on the experience and judgment of the evaluator (Cederstrom, 2008). In the last few years the hydrologist's task has been to state categorically that the average yield of wells in various hard-rock formations is a certain number of gallons a minute. In dealing with this difficult problem, it must be understood clearly that the estimate arrived at in such a study cannot refer to the yield of a single well but rather to the average yield per well where a number of wells is considered. Nigerian population might experience a constant unabated increase in the next decades. By 2050, it is forecast that the population will grow to over 377 million people compared to 2022 and over 410 million people in 2054. Also, the current population of Nigeria in 2024 is 229,152, 217 while in the previous year (2023), the population was 223,804,632 which is a 2.41% increase from 2022. Currently, Nigeria's annual population growth rate has been projected to result in the doubling of its population of 229 million within 25 years (Statistica, 2024); hence, demographic pressures coupled with rising operational and maintenance cost of water infrastructure are affecting water supply of various residential communities in Nigeria which the study area is not an exception which necessitates this investigation. This study therefore examines the yield of water sources comprising of existing boreholes and hand-dug wells at different locations within Ewekoro Residential Community, South-West Nigeria.

MATERIALS AND METHODS

Study Area

Ewekoro community in Ogun State is one of the mills of West African Portland Cement Company (WAPCO) and Dangote group Cement Company. It is a sleepy neighbouring town to Papalanto, a name known for sugarcane plantation (Ishola, 2019). It lies between latitude $6^{0}53^{1}$N and longitude $3^{0}14^{1}$E. The sedimentary rocks of Ogun State consist of Ewekoro formation and Abeokuta formation. The Ewekoro formation is fossiliferous and consists of economic deposits of limestones that is quarried by WAPCO (Ishola, 2024). The Ewekoro formation is the local geology in the study area which is generally consistent with the regional geology of eastern part of the Dahomey Basin; predominantly comprises of the non-crystalline and highly non-fossiliferous limestone and thinly laminated fissile and probably non-fossiliferous shale (Ushie *et al.,* 2014). It is the sedimentary terrain of southwestern Nigeria. Ewekoro formation consists of intercalations of argillaceous sediment. The rock is soft and friable but in some places cement by ferruginous and siliceous materials (WAPCO, 2000; Obaje, 2009). The lithological units in Ewekoro formation are clayey sand, clay, shale, marl, limestone and sandstone (Ishola and Gbadebo, 2024). The study area is found in sedimentary area within Dahomey Embayment (Fig. 1), the political divisions of the study area within Nigerian continental environment is shown with inset map (Fig. 2), while the map displaying each of the investigated sites within the study area is also shown (Fig. 3). Fig. 3 also serves as a basemap showing the location and accessibility of the study area through the major and minor roads in Ewekoro Local Government Area of Ogun State. The entire study area is generally accessible by major roads and several footpaths, although the road from Abeokuta town to the investigated area is tarred. In addition to Ewekoro-Papalanto road, the survey locations can equally be accessed through a major road from Lagos State through Sango-Ifo express road (Ishola, 2024; Ishola and Gbadebo, 2024).

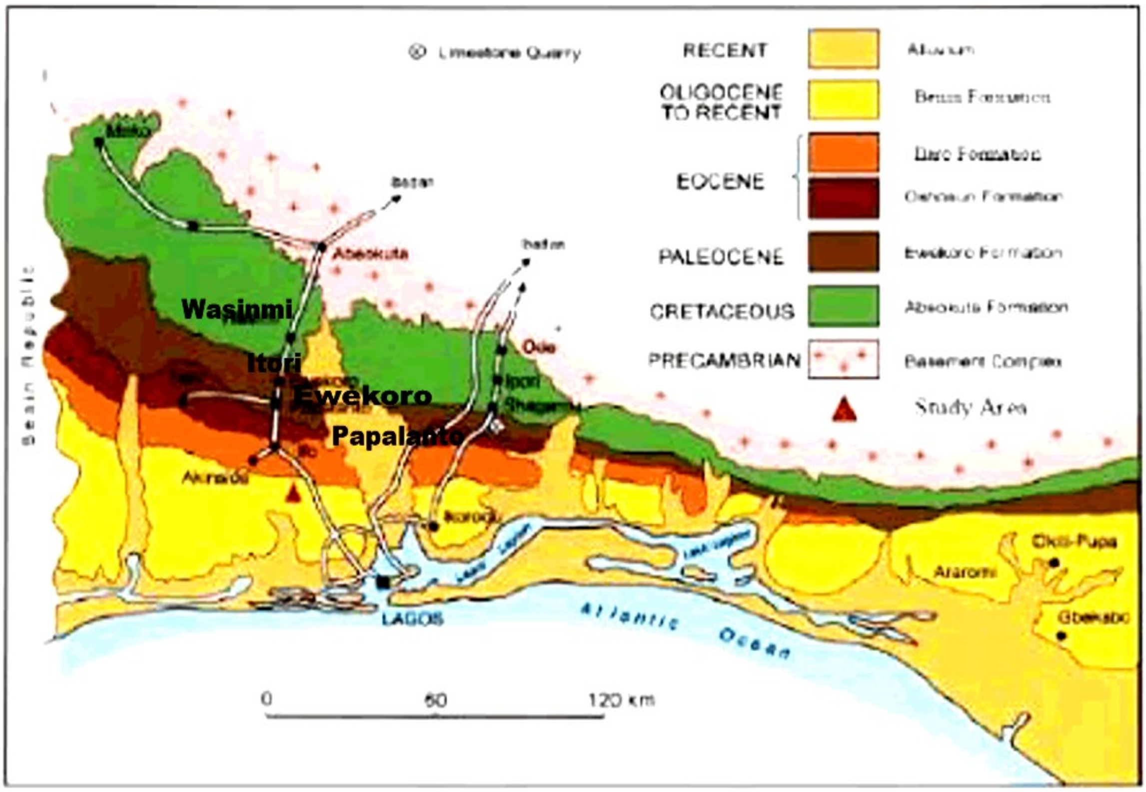

Figure 1: Geological Map of the Selected Locations of the Study Area within the Nigerian Part of Dahomey Embayment (after Billman, 1992; modified by Ishola, 2019).

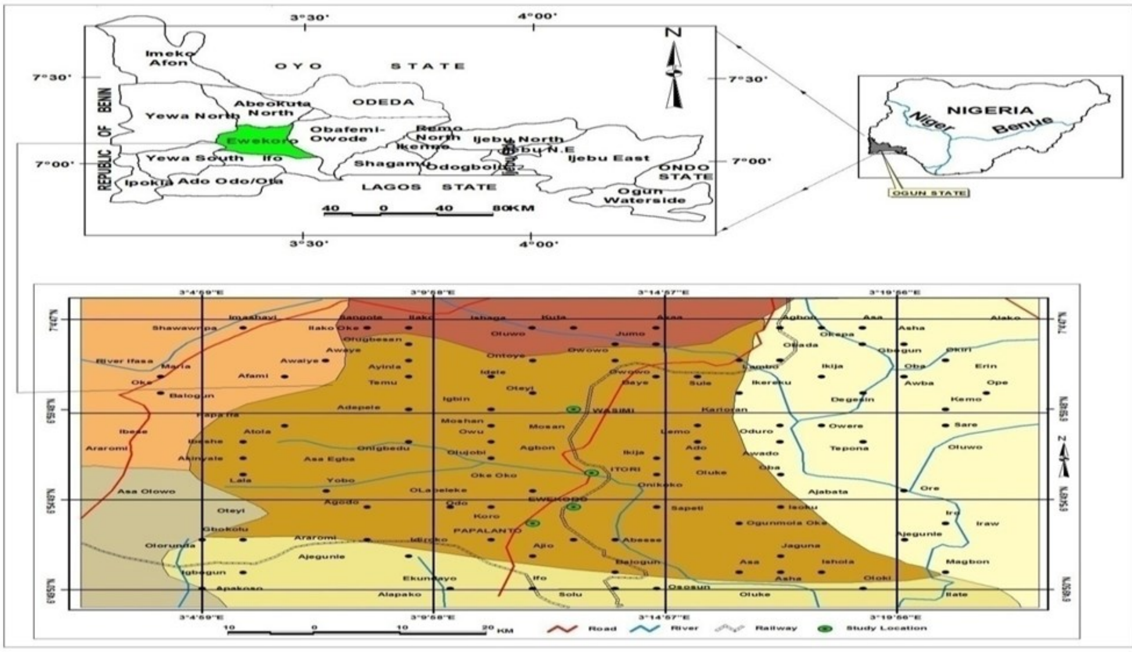

Figure 2: Inset Map showing the Study Areas in Ogun State within Nigeria Continental
Domain using Esri Data/Nigeria Political Information in Arcview GIS 3.2A Environment (Ishola, 2019**).**

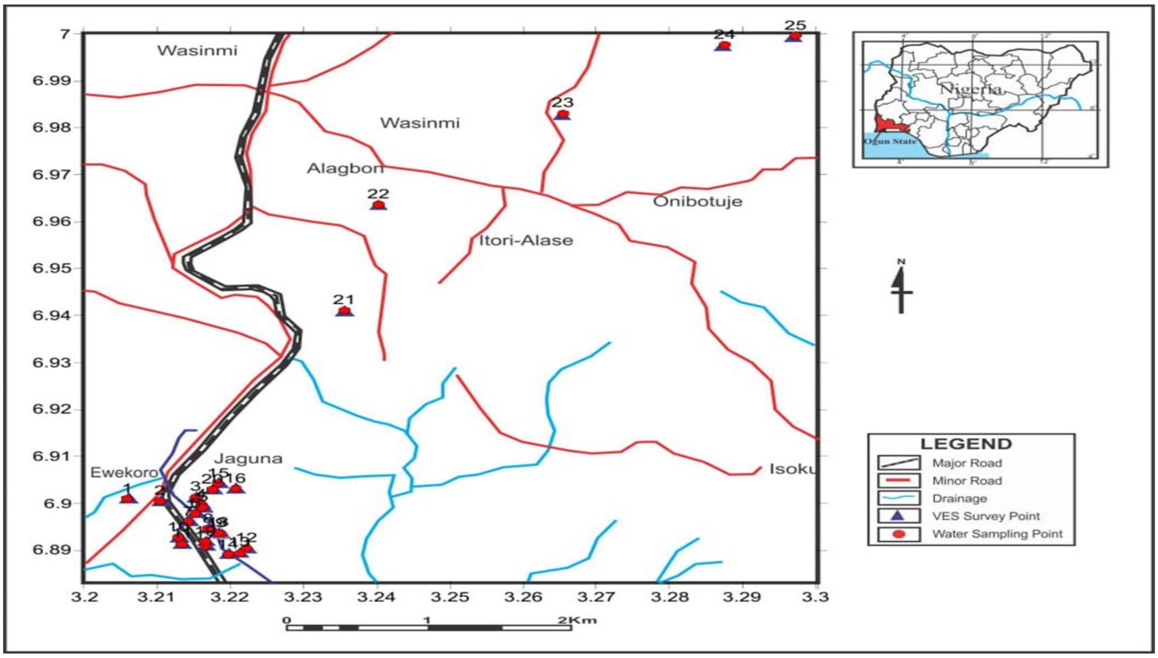

Figure 3: Data Acquisition Map showing the Investigated Locations in Ewekoro Study Area in Ewekoro LGA, Southwest Nigeria (Ishola, 2019**)**

Theoretical background

A pumping-test method to determine the specific yield of a water- table aquifer was presented by Ishola and Gbadebo, (2024). Hydrogeologists determine the hydraulic characteristics of water-bearing formations by conducting pumping tests. Pumping test is primarily conducted to evaluate the aquifer response under controlled and monitored conditions to the abstraction of water (Balasubramanian, 2017). The underlying principle governing pumping test involves pumping water from a well and measure the rate of pumping as well as the drawdown exhibited by the pumped well, the hydraulic parameters of the aquifer can be determined by the integration of the observed measurement with the appropriate empirical formula (Balasubramanian, 2017; Lv *et al.,* 2021; Ishola and Gbadebo, 2024). The method involves the determination of the volume of dewatered material in the cone of depression during the course of a pumping test. The specific yield is then determined by comparing the volume of dewatered material with the total volume of discharged water. The calculation of the volume of dewatered material requires the solution of an exponential series that converges very slowly and is, therefore, time consuming. The example presented by needed 60 terms of the series and required more than 3 hours of computation. This is a more easily evaluated equation for rapidly computing the volume of dewatered material in the cone of depression (Ramsahoye and Lang, 1993).

As pointed out earlier by Balasubramanian, 2017 and Lv *et al.*, 2021; it may not be possible to apply the standard formulae to data from a pumping test in a shallow water- table aquifer because of the slow drainage of the aquifer material during the test and (or) because of a varying rate of discharge. However, the general equilibrium formula can be applied if a pumping rate Q is constant for a long enough periods so that the cone of depression reaches approximate equilibrium form and is declining only very slowly. As pumping continues, a hydraulic gradient that is essentially an equilibrium gradient will be established close to the pumped well, and water will be transmitted to the well through the water-bearing material in approximately, the amount that is being pumped. The decline of the water table and the resulting unwatering of material in this area will then be much slower. The assumptions used in the development of the general equilibrium formula and those used by Ishola, (2019) also apply here. The following is quoted from (Ishola, (2019); Sule *et al.,* (2013) and Ramsahoye and Lang, (1993)). "Although the water table continues to decline slowly, the assumption that steady-state conditions have been reached involves only, slight error no greater than that resulting from such a cause as fluctuation in pump discharge. An isotropic and homogeneous water-bearing bed of infinite areal extent is assumed to rest on a relatively impervious formation. The discharging well, equipped with a pump, is fully screened to the bottom of the water-bearing material. It is assumed that water movement from the outer radius of the screen to the pump intake occurs without loss of head or with a head loss that is insignificant compared with the drawdown in the well. The water table before pumping, and the underlying impervious bed, are assumed to be horizontal. It is assumed also that there is no recharge to the aquifer during the test and that all the water pumped is removed from storage.

The following symbols or nomenclature are used in the mathematical derivations in this

report:
K = hydraulic conductivity (LT^{-1})
$\frac{\rho}{\gamma}$ = hydrostatic pressure potential (L)
Z = gravitational potential (L)
The negative sign indicates that the flow moves in the direction of decreasing head, v_s defines the flow rate in any direction through a porous medium is proportional to the negative rate of change of head in that direction.
Q = the discharge rate of the pumped well in gallons per day
P = the field coefficient of permeability of the aquifer in gallons per day per square foot under a unit hydraulic gradient and at the prevailing water temperature
r = the horizontal distance from the axis of the pumped well to a point on the cone of depression, in feet
s = the drawdown at distance r, in feet
s_w = the drawdown just outside the screen of the pumped well, in feet

m = the thickness of the zone of saturation before pumping or the height of the static water table above the aquifer bottom, in feet
T = Pm = the coefficient of transmissibility of the aquifer in gallons per day per foot. It is the flow through a vertical strip of the aquifer 1 foot wide and extending the saturated height of the aquifer, at unit hydraulic gradient. Darcy's law can be written in a differential form where the velocity of the flow in this direction is

$$v_s = \frac{K\partial(\frac{\rho}{\gamma}+Z)}{\partial s} \quad 1.0$$

Differentiating the head; h(x,y,t) = $\frac{\rho}{\gamma} + Z$ with respect to s, we obtain

$$\frac{\partial h}{\partial s} = \frac{\partial(\frac{\rho}{\gamma}+Z)}{\partial s} \quad 2.0$$

Substituting equation 2.0 into equation 1.0, we get

$$v_s = \frac{K\partial h}{\partial s} \quad \text{(Macleod, 1995)} \quad 3.0$$

From Darcy's law:

$$Q = 2\pi P\left(-\frac{\partial s}{\partial r}\right)(m - s) \quad 4.0$$

$$\frac{\partial r}{r} = -\frac{2\pi P}{Q}(m - s)\,\partial s = -a(m - s)\,\partial s \quad 5.0$$

Where a = $\frac{2\pi P}{Q}$

Integrating, $\ln r = -ams + \frac{as^2}{2} + \ln \beta$ 6.0

Where β is the constant of integration

Then $r = \beta e^{-\mathrm{ams}} + \frac{as^2}{2}$ 7.0

Equation 7.0 describes the cone of depression when it has reached virtually an equilibrium shape or position.

The volume of dewatered material in cubic feet, V within the cone of depression is

$$V = \int_0^{s_w} r^2 \, \partial s \qquad 8.0$$

The limits of integration being chosen at zero drawdown (for example, the extent of the cone at equilibrium) and the drawdown outside the screen of the pumped well. The value of r in equation 8.0 may be substituted in equation 5.0 to give

$$V= \pi\beta^2 \int_0^{s_w} e^{-2\mathrm{ams} + \frac{as^2}{2}} \, \partial s$$

9 . 0

the exponent in equation 9.0 may be written in the equivalent form [$-2\mathrm{ams} + (1 - \frac{s}{2m}$], $\frac{s}{2m}$ may be ignored because it is generally small compared to unity; therefore, equation 9 becomes

$$V= \pi\beta^2 \int_0^{s_w} e^{-2\mathrm{ams}} \, \partial s \qquad 10.0$$

$$V= \frac{\pi\beta^2}{-2\mathrm{ams}} \left[e^{-2\mathrm{ams}}\right]_0^{s_w}$$

11.0

$$V= \frac{\pi\beta^2}{2\mathrm{am}} \left[1 - \frac{1}{e^{2\mathrm{am}s_w}}\right]$$

12.0

For values found during field pumping tests, $2\mathrm{ams}_w > 1$

Hence, $\frac{1}{e^{2\mathrm{am}s_w}}$ is very small and can be ignored. Thus, equation 9.0 becomes

$$V= \frac{\pi\beta^2}{2\mathrm{am}} \qquad 13.0$$

From equation 7.0, $\beta = re^{\mathrm{ams}} - \frac{as^2}{2}$

Substituting the value for β in equation 13.0, we have equation 14.0 as follows

$$V = \frac{\pi r^2 e^{2\mathrm{ams}} - as^2}{2\mathrm{am}} \qquad 14.0$$

If the exponent of e is again modified, in the manner shown in equation 10, it follows that equation 15.0 may be written in the form

$$V = \frac{\pi r^2 e^{2am\,s}}{2am} \qquad 15.0$$

In equation 15.0, the volume of dewatered material is expressed in terms of permeability, pumping rate, horizontal distance, drawdown and aquifer thickness.

In the field practice, it is often necessary to make pumping tests using wells that only perfectly penetrate the aquifer or for which incomplete data are available. Thus, it may be not be possible to determine the coefficient of permeability, ***P*** or the full aquifer thickness, m under such circumstances, equation 7.0 cannot be used to determine the volume of dewatered material in the cone of depression. However, if the drawdown, **s** at the point of observation is small compared to suspected thickness of the zone of saturation, the thickness may be assumed to remain uniform and Transmissibility, **T** may be used in place of the unknown permeability and aquifer thickness ($T = Pm$).

Several standard groundwater formulae permit the direct determination of the coefficient of transmissibility. Therefore, equation 15.0 may be further modified by substituting therein the equivalents $\frac{2\pi P}{Q}$ for a and T for the product Pm, which yields

equivalents $\frac{2\pi P}{Q}$ for a and T for the product Pm, which yields

$$V= \frac{\pi r^2 e^{4\pi \frac{T_s}{Q}}}{\frac{4\pi T}{Q}}$$

$$V= \frac{Q r^2 e^{4\pi \frac{T_s}{Q}}}{4T} \qquad 16.0$$

Taking the logarithm of both sides of equation 16.0 produces

$$\text{Log V} = \text{Log} \frac{Qr^2}{4T} + \frac{4\pi T_s}{Q} \text{ Log e}$$

$$\text{Log V} = \text{Log} \frac{Qr^2}{4T} + \frac{5.45\ T_s}{Q} \qquad 17.0$$

The specific yield is the volume of water pumped during the test divided by the gross volume of dewatered material within the cone of depression (Ramsahoye and Lang, 1993; Macleod, 1995).

$$S = \frac{Qt}{7.48V}$$

Where S = specific yield
Q = average discharge rate of the pumped well in gallons per day
T = time in days, since pumping began
V = volume of dewatered material in cu.ft delivered from either equation 15.0 or 17.0
The formulae derived herein may be used only with data from an equilibrium pumping test and the test should be long enough to permit the greatest possible dewatering in the cone of depression without it being affected by recharge (Ramsahoye and Lang, 1993).

Data Acquisition

Pumping tests were conducted on twenty-five selected boreholes and twenty five hand -dug wells cut across Ewekoro area, with the view to ascertain yield of the wells. The results of this study will go a long way to enhancing the water resource management planning**.** Two major sources of data were used in this study. These are primary and secondary data. The primary data consisted of reconnaissance survey and personal visits to locations of existing boreholes and hand-dug wells in the study area, identifying sampling points and collecting well inventory. Practicing consultants on borehole drilling in Ewekoro Local Government Area were also contacted for information on the boreholes drilled in the study area. The secondary data consisted of published and unpublished documents for relevant information. Such information were extracted from journals, conference papers and available textbooks. Existing drilled boreholes were identified across the study areas and where there were no boreholes the existing hand-dug wells were used, and well inventory were collected. The depth of the boreholes and the overburden thickness were measured using dip-meter while GPS was used to acquire the coordinates used in producing the data acquisition map of the study area displayed above in Fig. 3. Two different methods were used in conducting pumping tests on the selected boreholes and hand dug wells. These methods are constant rate pumping test and recovery method test.

Constant rate pumping test

Constant rate pumping tests were conducted on the selected boreholes. The materials used for these tests included; 60-litre gallons as a standard measure, generating set to power the pump, stop watch to record time intervals and rubber hose connected to the pipe from the borehole to discharge the water into the gallons. In conducting this test, the initial or static level of the water in the boreholes was measured using a dip-meter. The generating set was thereafter switched on to start the pumping. The pumping was allowed to run continuously for a long period of two hours before the rate of pumping was adjusted for the boreholes to maintain constant discharge. At this point, the water level was measured to know the drawdown and a calibrated 60-litre gallon was then filled from the constant discharge from the boreholes while a stopwatch was simultaneously set to record the time taken, in seconds, to fill the bucket. This process was repeated for four hours for each of the selected boreholes. It was therefore observed that the water level and the drawdown in the boreholes were constant throughout the four hours pumping. With the constant discharge from the boreholes, a state of equilibrium was maintained between the rate of discharge and the rate of recharge from the aquifer. In this condition of equilibrium, the rate of pumping or discharge is directly proportional to the yield of the borehole or well at the constant drawdown. In other words, the discharge per unit time in litre per second gives the yield of each of the selected boreholes at the constant drawdown.

Recovery Method Test

Recovery method test was conducted on the selected hand-dug wells. The materials used for this test included; dip-meter., generating set and stop watch. In conducting the test, dip-meter was dipped into the well to determine the overall depth of the well and the water level before pumping started. The generating set was then put on to power the pump and the water in the well was gradually pumped out until the bottom level of the well was reached. The stop watch was also set to record the time taken for the pumping as the water level in the well reduced at different depth interval. As soon as the bottom of the well was reached, the well was left to recharge while the stop watch also recorded the time taken for the water to come back to original level before pumping started. The volume of the water pumped was calculated by measuring the diameter and the overall depth of the well. The ratio of the volume of water to the time taken gave the rate of the pumping in litre per second while the volume per day (m^2/day) gave the yield of the well.

RESULTS AND DISCUSSION

In Ewekoro Boreholes, the sedimentary rock mass aquifer system yielded up to 6.0 $\times 10^{-2}$ l/s while the depths to the boreholes were found to range from 35m and 100m with the average of 60.32m (Table 1.0) as compared with Ilorin basement of 17 to 60m with an average of 32.9m (Sule *et al.,* 2013; Muraina, 2009); Ado-Ekiti basement of 40 to 120m (Ale *et al.,* 2015) and Malawi basement of 24 to 75m with an average of 24.1m (Chilton and Smith-Carington, 1984; Ohenhen *et al.,* 2023). The yield was not totally dependent on the depths, but also on such parameters as porosity and permeability (Ishola, 2019). The typical specific yields for an unconfined aquifer are in the order of 1% to 30% (Watson and Burnett, 1995; Ishola and Gbadebo, 2024). The high values obtained for the study area reflects the potential for a high storage or water holding capacity of the aquifers. This is understandable in view of the clayey materials (which has high capacity for storing water but low capacity for transmitting it) derived from the weathering of the highly carvernous karst limestone and saturated sandstone rocks constituting the aquifers (Rasmussen and Mote, 2007; Rasmussen and Crawford, 1997; Ishola *et al*., 2019; Ishola and Gbadebo, 2024). Borehole discharge ranged from 3.0 $\times 10^{-2}$ to 6.0 $\times 10^{-2}$ l/s with an average of 4.0 $\times 10^{-2}$ l/s (Table 1.0) as compared with the same Ilorin basement complex of 2.4 $\times 10^{-1}$ to 25.0 $\times 10^{-1}$ l/s with an average of 8.9 $\times 10^{-1}$ l/s; Ado-Ekiti basement of 2.6 $\times 10^{-1}$ to 0.26 $\times 10^{-1}$ l/s and Malawi basement of 0.025 $\times 10^{-1}$ to 5.0 l/s with an average of 0.078 $\times 10^{-1}$ l/s. The value of Transmissibility ranged from 8.64 to 6912 m^2/day with an average value of 777.6 m^2/day as compared to Ilorin basement complex that ranged between 7.184 and 447.954 m^2/day with an average of 49.12 m^2/day Malawi basement of 2.0 to 35 m^2/day. The Residual Drawdown (S') ranged between 3.53m and 11.6m with average residual drawdown of 7.48m (Table 1.0) while the average Static Water Level (SWL) was 22.1m within a range of 4.41m to 48.1m, mean Specific Capacity (Cs) and Well Loss Constant (WLC) were 6.0×10^{-3} m^2/s and 0.616×10^{4} s^2/m^5 respectively, with maximum Transmissibility (T) of 8.0×10^{-2} m^2/s (6912 m^2/day). The longest recovery period was 3150 seconds (EWEBH15) seconds and the lowest recovery period was 1566 seconds (EWEBH22) with average recovery period of 2483 seconds (41.4 minutes) while the variation for specific discharge from individual boreholes in the study area is displayed in Figure 6a. Among the tested aquifer properties, optimum operating capacity is the least variable parameter, having coefficient of variation (CV) of 13% (Table 1); this is in agreement with findings of Knopman and Holliday (1993) followed by recovery period and (t/t') alongside specific discharge with CV of 22% and 25% respectively (Table 1.0).

In Ewekoro hand-dug wells, the sedimentary rock mass aquifer system yielded up to 6.0×10^{-2} l/s while the depths to the boreholes were found within the range from 4.7m to 17.5m, with the average depth of 8.28m. Well discharge ranged from 1.0×10^{-2} to 6.0×10^{-2} l/s, with an average of 2.0×10^{-2} l/s. Also, the value of Transmissibility ranged from 8.64 to 35,424 m^2/day with an average value of 7344 m^2/day. The Residual Drawdown (S') ranged between 0.17m and 1.83m, with average residual drawdown of 0.93m while the average Static Water Level (SWL) was 2.04m within a range of 0.64m to 4.94m, mean Specific Capacity (Cs) and Well Loss Constant (WLC) were 6.2×10^{-2} m^2/s and 1.247×10^{4} s^2/m^5 respectively, with maximum Transmissibility (T) of 4.1×10^{-1} m^2/s (35,424 m^2/day). The longest recovery period was 15732 seconds (EWEWW15) seconds and the lowest recovery period was 1476 seconds (EWEWW22) with average recovery period of 7961 seconds (132.7 minutes) while the variation for specific discharge from individual hand-dug well in the study area is displayed in Figure 6b. Among the investigated hydraulic parameters in Ewekoro hand-dug wells, well diameter is the least variable parameter followed by well depth having coefficient of variation (CV) of 21% to 39% (Table 2.0).

Well loss constant is the well loss coefficient because it is constant for a given flow rate. The significance of the well loss constant is experienced during pumping when water is pumped out of a well, the total drawdown exhibited includes not only that of the logarithmic drawdown curve of the well face but drawdown generated by flow through well screen and axial movement within the well. This later drawdown depicts the well loss but the well loss constant describes the linear component of the drawdown meaning satisfying the part in which doubling the pumping rate doubles the drawdown. It explains well losses; the non-linear component of the drawdown. While aquifer loss is proportional to the pumping rate, well loss is assumed to be proportional to the square of pumping rate (Ishola, 2019). Also, the optimum operating capacity grants a clue to understanding borehole strength in terms of yield. It determines the balance between the maximum amount of water that can be pumped out of a well and the amount of water that recharges back into the well from the surrounding groundwater source (Ishola, 2019; NAKISO, 2024). In general, all other parameters have coefficient of variation above 10 %. This implies that the variation caused by the aquifer system on DD, SWL, BHD, Q, Cs, WLC, OOC and T is high enough to be significant in hydrogeological system of Itori Boreholes (Pollaco *et al.,* 2024; Ishola, 2019). Aquifer potentiality is related to the transmissivity value and also the unit of this parameter.

Transmissibility is a very important hydraulic property of an aquifer being the ratio of water of prevailing density and viscosity drained through a unit width of an aquifer or confining bed under a unit hydraulic gradient. It is a function of the properties of the liquid, the porous media and the thickness of the porous media (Ishola, 2019). High Transmissibility values imply high potentiality as well as high production capacity. According to potentiality classification Transmissibility greater than 500 is considered as High Potentials (Sen-Zekai, 2015; Akpan *et al.,* 2024; Ali *et al.,* 2022; Beven, 2024). According to Ishola, 2024, the aquifer thickness for the study area ranged from 5.62 to 93.7m with average thickness of 36m while that of Itori district (closest neighbouring town) ranged from 8.61 to 88.50m with average thickness of 30m. The aquifer thickness and static water level information would go a long way in assisting the driller on the selected numbers of casing/screen to be used during the drilling operations while the depth would assist the driller to prepare cost estimates of drilling because it is based on the length of the metre drilled (Sule *et al.,* 2013; Ishola et al., 2016); the adjoining parameters are greatly significant for selecting the type of scheme to be executed be it manpower (manual) or motorized pump well system.

Yield and Specific Capacities of Selected Boreholes in Ewekoro

It is observed that the lowest yield of 2.864 $\times 10^{-2}$ litre/second was recorded at EWEBH5 around Agbesi alongside EWEBH15 around Ikeja and the highest yield of 5.747 $\times 10^{-2}$ litre/second was recorded at EWEBH8 around Sapeti (Table 1.0); this is complemented with the variation in the yields of the selected borehole sites illustrated in Figure 7a. It can be deduced from values of the yield that groundwater can be assessed at varying proportions all over Ewekoro. This implies high potential in quantity. However, there is a need to verify this by extensive geophysical survey. The drawdown of the selected boreholes ranged between 3.53m at EWEBH25 around Akinbo and 11.55m at EWEBH2 around Agbesi while the specific capacities range between 2.710 $\times 10^{-3}$ m^2/s at EWEKO2 around Agbesi and 9.740 $\times 10^{-3}$ m^2/s at EWEBH1 at the southern end of Agbesi. The variation in the specific capacity value is significant because it measures the productive capacity of a borehole or well and it helps in the selection of the appropriate pump for the borehole (Sule *et al.,* 2013; Ishola, 2019; Ishola and Gbadebo, 2024).

Yield and Specific Capacities of Selected Hand-dug Wells

From the table 2.0, the yield ranged between 5.721 $\times 10^{-3}$ litre/second at EWEWW15 around Ewekoro central and 60.976 $\times 10^{-3}$ litre/second at EWEWW22 around Akinbo. The table also shows specific capacity of 3.126 $\times 10^{-3}$ m^2/s at EWEWW15 around Ikeja and 241.08 $\times 10^{-3}$ m^2/s at EWEWW4 around Agbesi Estate while the drawdown varies from 0.17m at EWEWW4 around Agbesi to 1.73m at EWEWW18 around Akinbo; also, the variations in the yields of the selected hand-dug well sites are illustrated in Figure 7b.

Table 1: Basic and Estimated Hydraulic Parameters of Studied Aquifer Systems of Ewekoro Boreholes

	BASIC HYDRAULIC PARAMETERS						ESTIMATED HYDRAULIC PARAMETERS				
Locations	Well Head (m)	Bore-hole Depth BHD (m)	Borehole diameter BHDT (mm)	Static Water Level SWL (m)	Residual Draw-Down DD (m)	Time (s)	Specific Discharge Q (l/s)	Specific Capacity Cs (m^2/s)	Well Loss WLC (s^2/m^5)	Transmissibility T (m^2/s)	Optimum Operating Capacity OOC
EWEBH1	0.28	52	140	9.92	4.88	1894	4.753×10^{-2}	9.740×10^{-3}	0.2160×10^{4}	0.1169×10^{-3}	4.6292×10^{-4}
EWEBH2	0.25	38	25	13.57	11.55	2887	3.117×10^{-2}	2.711×10^{-3}	1.1886×10^{4}	3.253×10^{-3}	0.8450×10^{-4}
EWEBH3	0.15	40	25	14.35	9.81	2934	3.067×10^{-2}	3.127×10^{-3}	1.0426×10^{4}	0.03752×10^{-3}	0.9592×10^{-4}
EWEBH4	0.19	83	110	43.31	9.25	2743	3.281×10^{-2}	3.547×10^{-3}	0.8594×10^{4}	4.256×10^{-3}	1.164×10^{-4}
EWEBH5	0.22	40	140	15.03	3.57	3143	2.864×10^{-2}	8.022×10^{-3}	0.4353×10^{4}	9.626×10^{-3}	2.2970×10^{-4}
EWEBH6	0.38	45	110	4.41	9.19	2826	3.185×10^{-2}	3.465×10^{-3}	0.9061×10^{4}	4.159×10^{-3}	1.1040×10^{-4}
EWEBH7	0.38	75	110	37.92	9.60	2959	3.041×10^{-2}	3.168×10^{-3}	1.0379×10^{4}	3.802×10^{-3}	0.9635×10^{-4}
EWEBH8	0.40	80	110	39.36	7.79	1566	5.747×10^{-2}	7.378×10^{-3}	0.2359×10^{4}	8.853×10^{-3}	4.2402×10^{-4}
EWEBH9	0.30	95	140	48.05	5.50	1699	5.297×10^{-2}	9.630×10^{-3}	0.1961×10^{4}	0.1156×10^{-3}	5.1013×10^{-4}
EWEBH10	0.36	60	110	12.94	7.61	1760	5.144×10^{-2}	6.760×10^{-3}	0.2876×10^{4}	0.8112×10^{-3}	3.4772×10^{-4}
EWEBH11	0.30	40	110	11.40	8.98	2959	3.041×10^{-2}	3.387×10^{-3}	0.9708×10^{4}	4.064×10^{-3}	1.0302×10^{-4}
EWEBH12	0.28	45	25	5.12	10.57	1901	4.735×10^{-2}	4.480×10^{-3}	0.4715×10^{4}	5.375×10^{-3}	2.1213×10^{-4}
EWEBH13	0.33	40	110	14.27	7.57	1570	5.734×10^{-2}	7.575×10^{-3}	0.2302×10^{4}	9.090×10^{-3}	4.5432×10^{-4}
EWEBH14	0.42	35	110	12.22	9.77	2970	3.030×10^{-2}	3.102×10^{-3}	1.0640×10^{4}	3.722×10^{-3}	0.9399×10^{-4}
EWEBH15	1.12	40	110	14.30	8.60	3150	2.857×10^{-2}	3.322×10^{-3}	1.0535×10^{4}	3.987×10^{-3}	0.9492×10^{-4}
EWEBH16	1.25	72	110	38.18	9.57	2959	3.041×10^{-2}	3.178×10^{-3}	1.0346×10^{4}	3.814×10^{-3}	0.9666×10^{-4}
EWEBH17	1.31	70	110	31.90	9.38	2830	3.181×10^{-2}	3.391×10^{-3}	0.9272×10^{4}	4.069×10^{-3}	1.2434×10^{-4}
EWEBH18	0.63	110	110	44.69	7.51	1894	4.753×10^{-2}	6.329×10^{-3}	0.3325×10^{4}	7.594×10^{-3}	3.0083×10^{-4}
EWEBH19	0.42	65	110	14.83	9.18	2974	3.027×10^{-2}	3.297×10^{-3}	1.0021×10^{4}	3.956×10^{-3}	0.9979×10^{-4}
EWEBH20	0.47	65	140	14.36	4.62	2250	4.000×10^{-2}	8.693×10^{-3}	0.2875×10^{4}	1.043×10^{-3}	3.4783×10^{-4}
EWEBH21	0.73	76	140	33.55	3.72	2621	3.434×10^{-2}	9.231×10^{-3}	0.3155×10^{4}	1.108×10^{-3}	3.1705×10^{-4}
EWEBH22	1.25	62	140	14.50	4.62	2599	3.463×10^{-2}	7.495×10^{-3}	0.3853×10^{4}	8.994×10^{-3}	2.9594×10^{-4}
EWEBH23	1.38	65	140	12.55	4.83	2257	3.987×10^{-2}	8.255×10^{-3}	0.3038×10^{4}	9.906×10^{-3}	3.2914×10^{-4}
EWEBH24	1.26	45	125	9.06	5.81	1778	5.061×10^{-2}	8.710×10^{-3}	0.2269×10^{4}	0.1045×10^{-3}	4.4084×10^{-4}
EWEBH25	0.48	80	125	42.74	3.53	2941	3.060×10^{-2}	8.669×10^{-3}	0.3770×10^{4}	0.1040×10^{-3}	2.6532×10^{-4}
MEAN	0.58	60.32	109.40	22.1	7.48	2483	4.0×10^{-2}	6.0×10^{-3}	0.616×10^{4}	9.00×10^{-3}	2.40×10^{-4}
MAX	1.38	100.0	140.00	48.1	11.6	3150	6.0×10^{-2}	1.0×10^{-2}	1.189×10^{4}	8.00×10^{-2}	6.00×10^{-4}
MIN	0.15	35.00	25.00	4.41	3.53	1566	3.0×10^{-2}	1.0×10^{-4}	0.196×10^{4}	1.00×10^{-4}	3.00×10^{-6}
S.D	0.41	19.15	34.41	14.3	2.45	555	1.0×10^{-2}	3.0×10^{-2}	0.365×10^{4}	1.5×10^{-2}	3.00×10^{-5}
CV (%)	71	32	32	65	33	22	25	50	59	166	13

Source: Field works 2017 and 2018 (Ishola, 2019)

Table 2.0: Basic and Estimated Hydraulic Parameters of Studied Aquifer Systems of Ewekoro Hand-Dug Wells

Locations	BASIC HYDRAULIC PARAMETERS						ESTIMATED HYDRAULIC PARAMETERS				
	Well Head (m)	Well Depth WD (m)	Well diameter MWD (m)	Static Water Level SWL (m)	Residual Draw-Down DD (m)	Time (s)	Specific Discharge Q (l/s)	Specific Capacity Cs (m^2/s)	Well Loss WLC (s^2/m^5)	Transmissibility T (m^2/s)	Optimum Operating Capacity OOC
EWEWW1	0.62	6.3	0.92	2.15	0.58	4618	19.490×10^{-3}	33.6022×10^{-4}	0.0152×10^{4}	40.323×10^{-3}	0.6549×10^{-3}
EWEWW2	0.33	7.8	1.13	2.06	1.51	12816	7.0225×10^{-3}	4.6506×10^{-4}	0.0312×10^{4}	5.5812×10^{-3}	3.2662×10^{-3}
EWEWW3	0.48	5.8	0.86	0.90	0.19	2268	39.6833×10^{-3}	208.862×10^{-4}	0.0125×10^{4}	250.62×10^{-3}	0.0829×10^{-3}
EWEWW4	0.32	4.8	0.86	0.64	0.17	2196	40.9843×10^{-3}	241.082×10^{-4}	0.0192×10^{4}	289.32×10^{-3}	0.0988×10^{-3}
EWEWW5	0.56	6.6	0.62	1.35	1.38	12132	7.4184×10^{-3}	5.3757×10^{-4}	2.5082×10^{4}	6.4512×10^{-3}	0.0399×10^{-3}
EWEWW6	0.74	9.3	0.80	3.53	1.17	9288	9.6899×10^{-3}	8.2820×10^{-4}	1.2463×10^{4}	9.9382×10^{-3}	0.0803×10^{-5}
EWEWW7	0.13	5.5	1.20	2.13	1.51	12816	7.0225×10^{-3}	4.6506×10^{-4}	3.0623×10^{4}	5.5803×10^{-3}	3.2665×10^{-3}
EWEWW8	0.35	4.7	0.83	1.41	0.91	8064	11.1611×10^{-3}	12.2653×10^{-4}	0.7324×10^{4}	14.723×10^{-3}	0.1369×10^{-5}
EWEWW9	0.22	5.2	1.35	1.64	1.46	12744	7.0622×10^{-3}	4.8372×10^{-4}	2.9273×10^{4}	5.8052×10^{-3}	3.4162×10^{-5}
EWEWW10	0.35	10.6	0.82	3.41	0.17	1872	48.0773×10^{-3}	282.811×10^{-4}	0.7362×10^{4}	339.43×10^{-3}	0.1360×10^{-3}
EWEWW11	0.64	16.2	1.4	4.94	1.61	13932	6.4600×10^{-3}	4.0124×10^{-4}	3.8532×10^{4}	4.8152×10^{-3}	2.5922×10^{-3}
EWEWW12	0.83	17.5	0.86	4.80	1.72	14490	6.2118×10^{-3}	3.6112×10^{-4}	4.4583×10^{4}	4.3332×10^{-3}	2.2432×10^{-5}
EWEWW13	0.65	8.3	0.75	1.21	0.91	6588	13.6613×10^{-3}	15.0123×10^{-4}	0.04883×10^{4}	18.023×10^{-3}	0.2051×10^{-3}
EWEWW14	0.83	10.3	0.78	2.94	0.39	3096	29.0702×10^{-3}	74.5383×10^{-4}	0.0463×10^{4}	89.452×10^{-3}	0.0217×10^{-3}
EWEWW15	0.85	8.9	0.86	1.48	1.83	15732	5.7208×10^{-3}	3.1264×10^{-4}	5.5923×10^{4}	3.7512×10^{-3}	1.7883×10^{-3}
EWEWW16	0.80	9.2	0.97	1.26	1.27	10116	8.8968×10^{-3}	7.0054×10^{-4}	1.6054×10^{4}	8.4062×10^{-3}	6.2334×10^{-3}
EWEWW17	0.28	6.6	0.78	1.52	0.22	1764	51.0203×10^{-3}	231.91×10^{-4}	0.0493×10^{4}	278.33×10^{-3}	0.1183×10^{-3}
EWEWW18	0.32	6.8	1.15	1.61	1.73	14580	6.1728×10^{-3}	3.5681×10^{-4}	0.5773×10^{4}	4.2821×10^{-3}	2.2035×10^{-3}
EWEWW19	0.53	6.7	0.81	1.48	0.34	3528	25.5103×10^{-3}	75.0302×10^{-4}	0.2662×10^{4}	90.044×10^{-3}	0.0191×10^{-3}
EWEWW20	0.24	7.3	0.86	1.04	1.12	8964	10.0402×10^{-3}	8.9644×10^{-4}	0.3373×10^{4}	10.763×10^{-3}	9.0000×10^{-5}
EWEWW21	0.53	5.8	1.13	0.95	1.04	9108	9.8814×10^{-3}	8.8227×10^{-4}	1.0652×10^{4}	10.592×10^{-3}	8.7183×10^{-5}
EWEWW22	1.13	13	0.80	3.64	0.18	1476	60.9763×10^{-3}	338.75×10^{-4}	0.0052×10^{4}	406.52×10^{-3}	0.2066×10^{-5}
EWEWW23	1.25	6.8	0.86	1.06	0.25	2808	32.0512×10^{-3}	128.213×10^{-4}	0.0243×10^{4}	153.92×10^{-3}	0.0411×10^{-3}
EWEWW24	1.26	8.6	0.88	2.80	0.39	4248	21.1863×10^{-3}	54.3243×10^{-4}	0.0874×10^{4}	65.192×10^{-3}	0.0115×10^{-3}
EWEWW25	0.81	8.4	1.07	1.03	1.09	9792	9.1912×10^{-3}	8.4323×10^{-4}	1.2902×10^{4}	10.123×10^{-3}	7.750×10^{-5}
MEAN	0.602	8.28	0.9340	2.04	0.93	7961	2.0×10^{-2}	6.2×10^{-2}	1.247×10^{4}	8.50×10^{-2}	1.20×10^{-3}
MAX	1.26	17.50	1.40	4.94	1.83	15732	6.0×10^{-2}	0.3×10^{-1}	5.592×10^{4}	4.1×10^{-1}	2.00×10^{-2}
MIN	0.13	4.70	0.62	0.64	0.17	1476	1.0×10^{-2}	1.0×10^{-4}	0.005×10^{4}	1.0×10^{-4}	1.00×10^{-6}
S.D	0.316	3.25	0.1931	1.21	0.59	4839	1.7×10^{-2}	9.8×10^{-2}	1.584×10^{4}	1.24×10^{-1}	1.70×10^{-3}
CV (%)	53	39	21	59	63	61	84	157	127	146	142

Source: Field works 2017 and 2018 (Ishola, 2019).

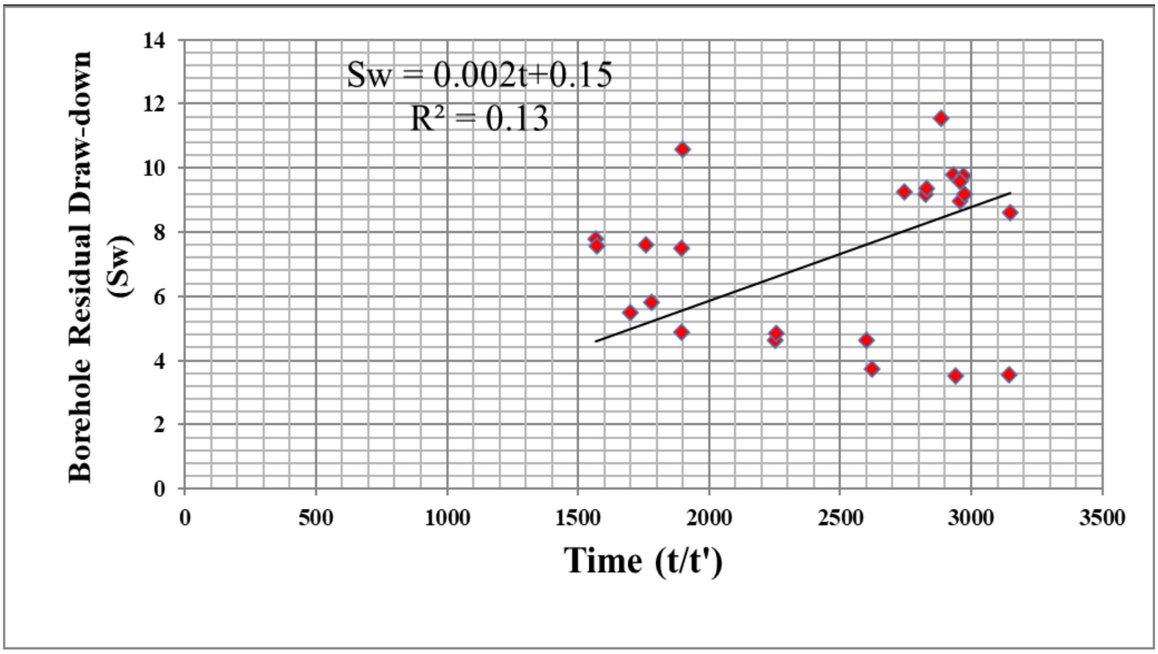

Fig. 4a: Plot of Residual Drawdown (Sw) and Time (T) on Semilog Scale for Ewekoro Borehole Sites

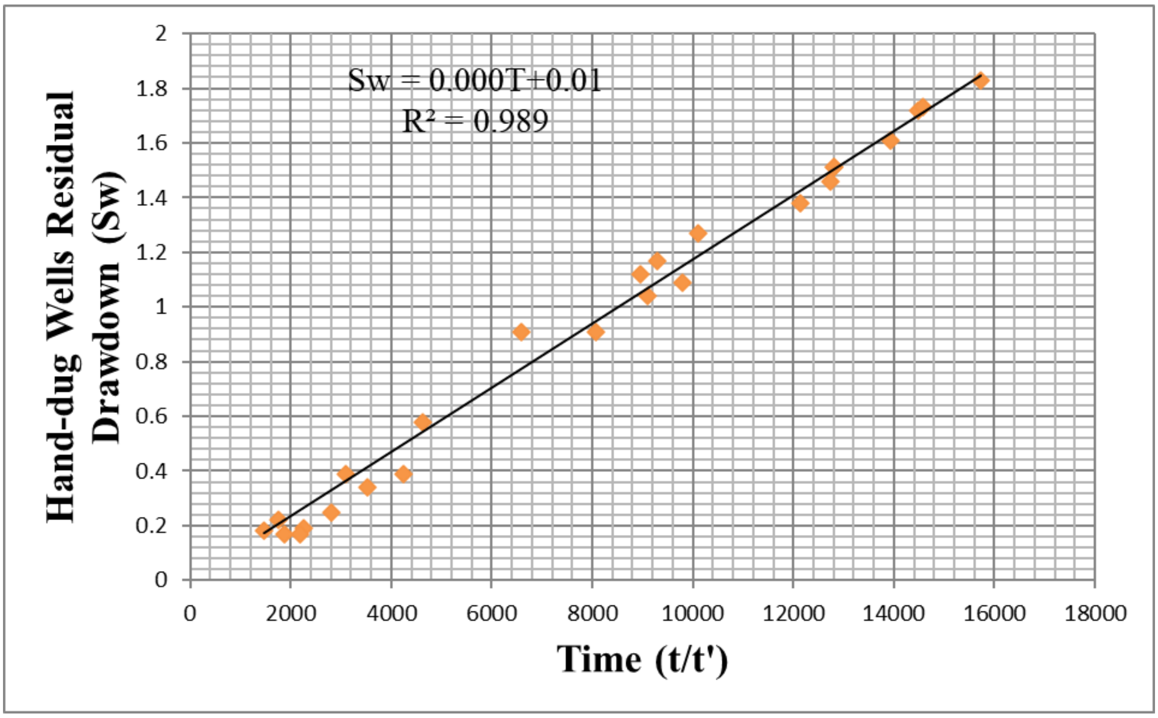

Fig. 4b: Plot of Residual Drawdown (Sw) and Time (T) on Semilog Scale for Ewekoro

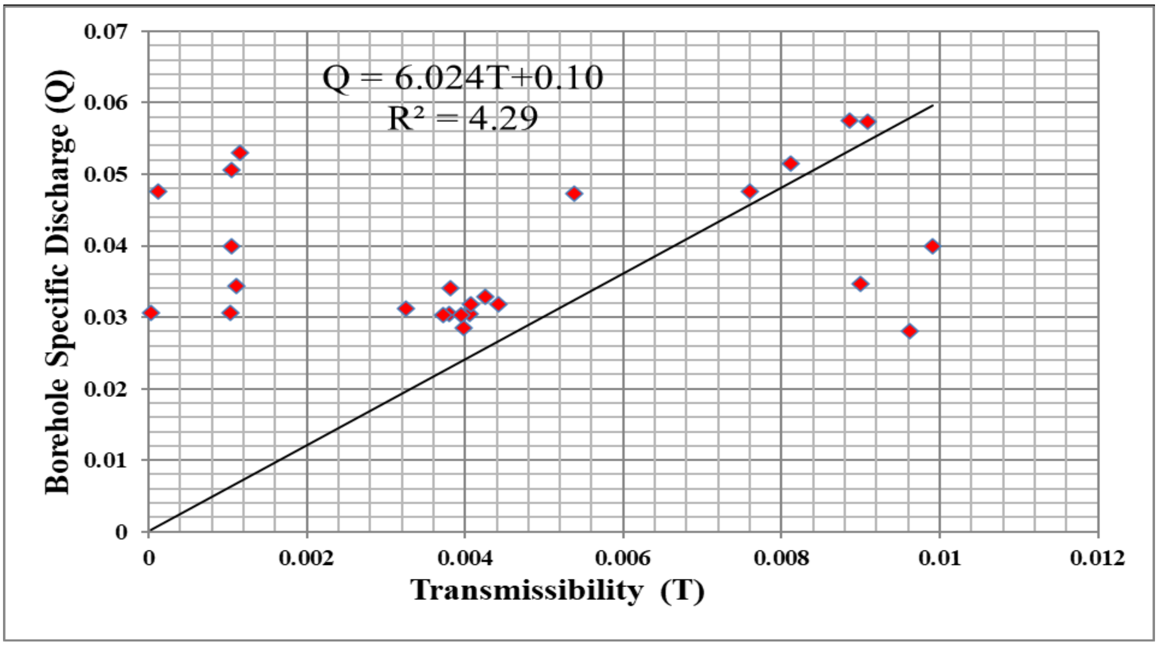

Figure 5a: Plot of Specific Discharge (Q) and Transmissibility (T) on Semilog Scale for Ewekoro Borehole Sites

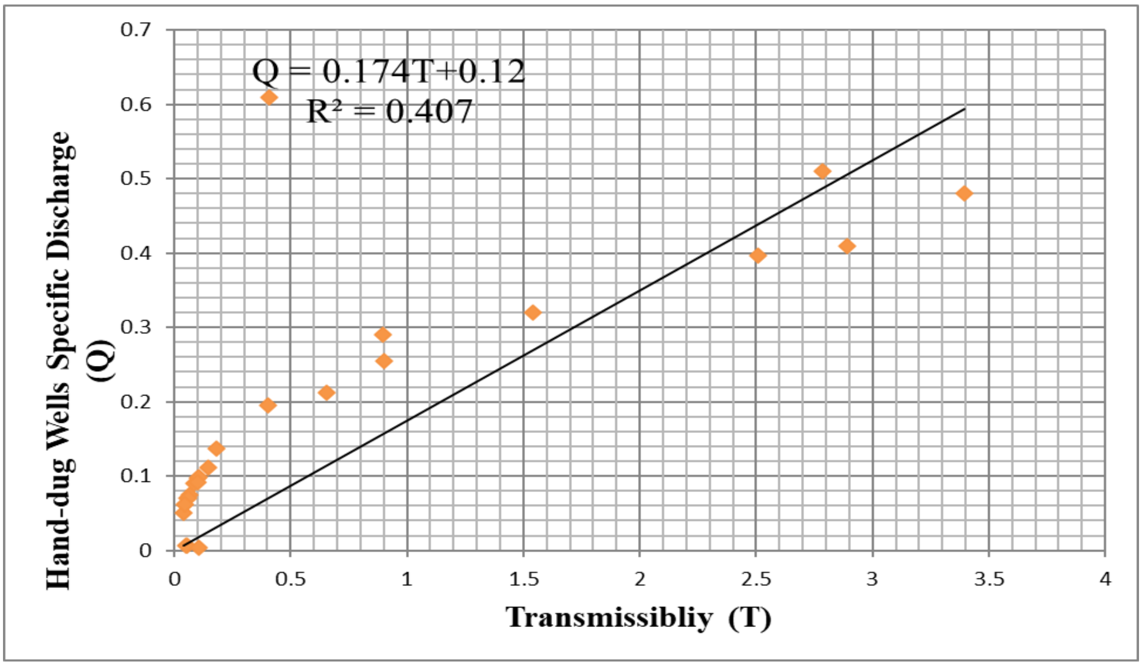

Figure 5b: Plot of Specific Discharge (Q) and Transmissibility (T) on Semilog Scale for Ewekoro Hand-dug Well Sites

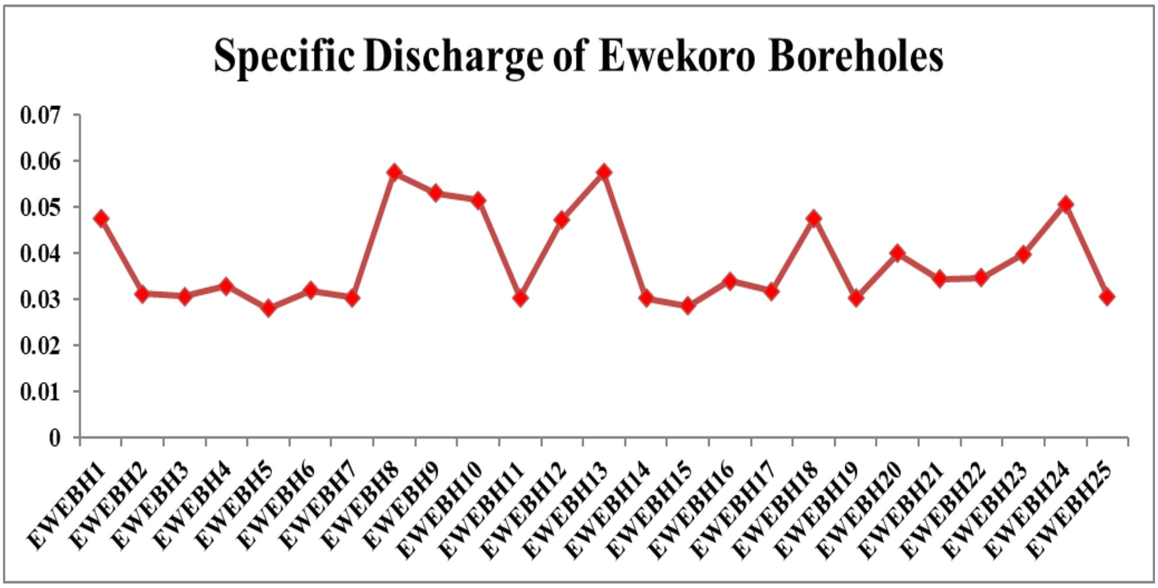

Figure 6a: Variation of Specific Discharge of Groundwater in Ewekoro Boreholes

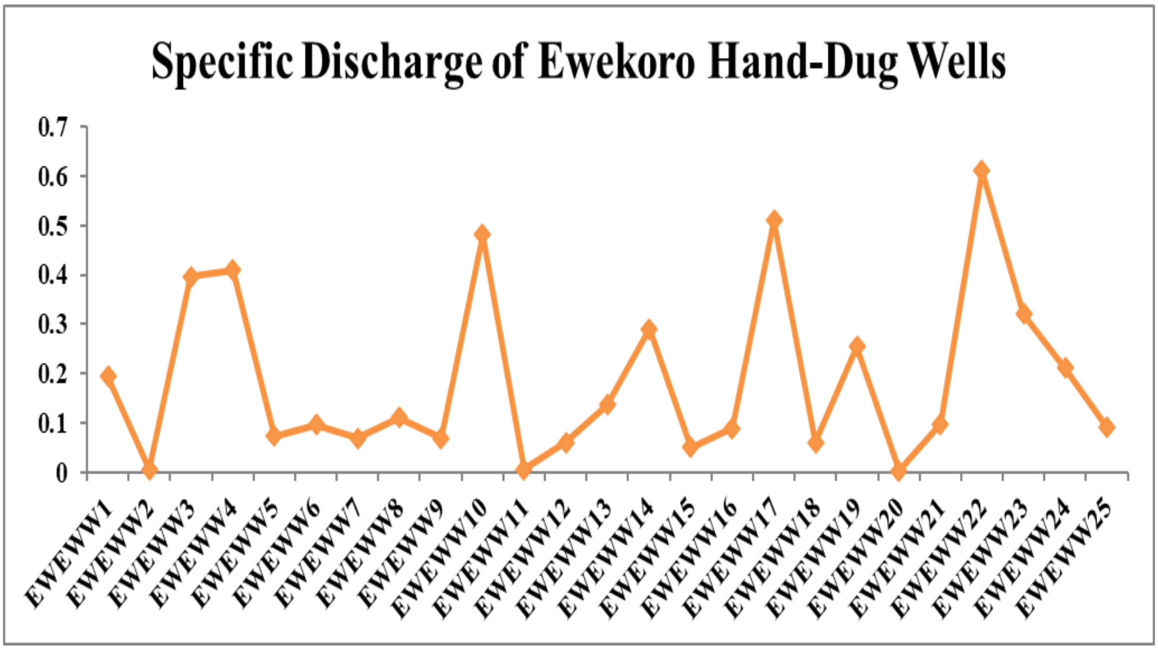

Figure 6b: Variation of Specific Discharge of Groundwater in Ewekoro Hand-dug Wells

Among the tested aquifer properties in Ewekoro Boreholes, Optimum Operating Capacity (OOC) is the least variable parameter, having coefficient of variation (CV) of 13% followed by Period of Recovery (t) in seconds with CV of 22%. In general, all other parameters have coefficient of variation above 10 %. Among the tested aquifer properties in Ewekoro hand-dug Wells, Measured Well Diameter (MWD) is the least variable parameter, having coefficient of variation (CV) of 21% followed by Well Depth (WD) with CV of 39%. In general, all other parameters have coefficient of variation above 10%. This implies that the variation caused by the aquifer system on DD, SWL, BHD, Q, Cs, WLC, OOC and T is high enough to be significant in hydrogeological system of Ewekoro Boreholes (Pollacco *et al.,* 2024 and Sen-Zekai, 2015).

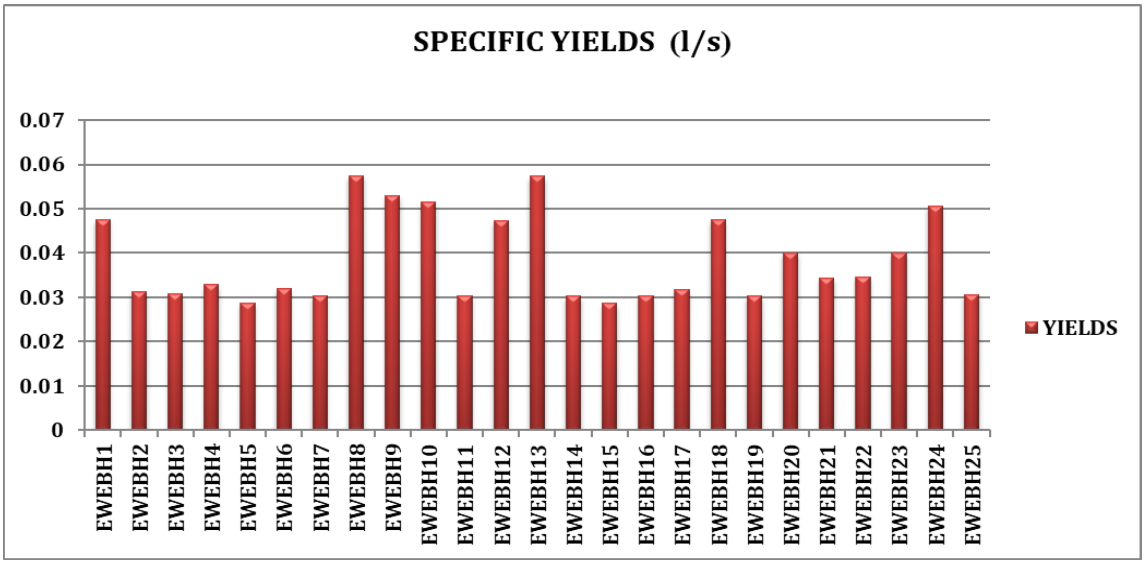

Figure 7a: Yield of Selected Boreholes in Ewekoro

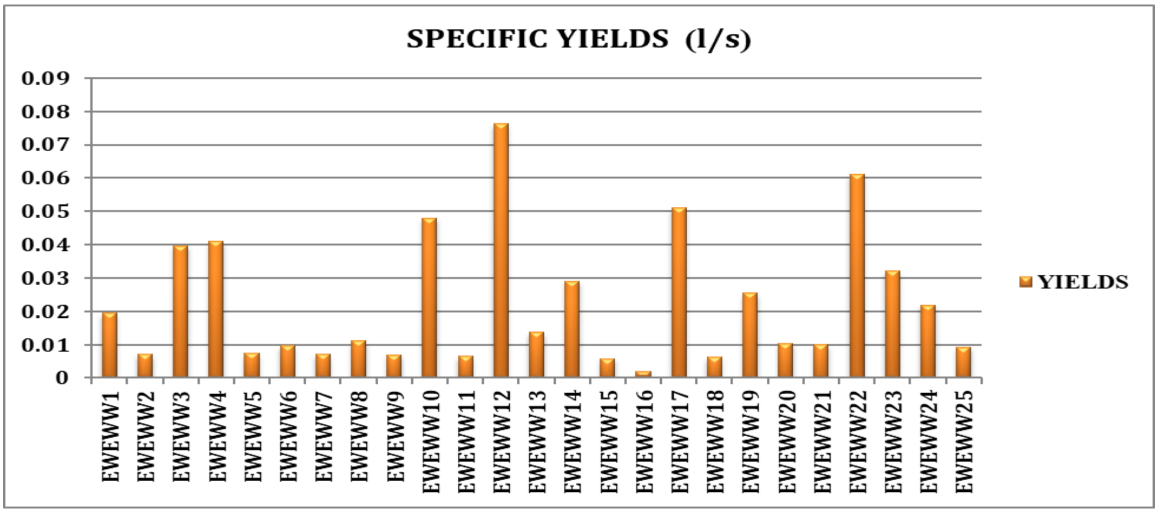

Figure 7b: Yield of Selected Hand-dug Wells in Ewekoro

CONCLUSION

Groundwater has served and still serving as a beneficial supplement to the surface water in Ewekoro residential community and entire Ewekoro Local Government Area of Ogun-State. The aquifer in the study area has been geohydraulically characterized revealing the varying parameters from two subsurface water sources namely boreholes and hand-dug wells and their contribution to groundwater yield. The weathered/ carvernous limestone and saturated sandstone rocks which constitute the aquifers in the study area, have variable relatively high transmissivities and high specific yields. The depths of the existing boreholes ranged from 35m to 100m with an average depth of 60.32m which is higher than the depth of hand-dug wells whose depths ranged from 4.7m and 17.50m with average depth of 8.28m. The borehole discharges ranged from 3.0×10^{-2} l/s to 6.0×10^{-2} l/s with an average discharge of 4.0×10^{-2} l/s while the discharges from the hand-dug wells ranged from 1.0×10^{-2} l/s to 6.0×10^{-2} l/s with an average discharge of 2.0×10^{-2} l/s; these values were found to be slightly lower than Ilorin, Ado-Ekiti, and Malawi Basement. This falls slightly below the range normally obtained in the investigated basement complex rocks which were characterized by low yield when compared to the ones obtained in other formations. Borehole transmissibility ranged from 8.64 to 6912 m^2/day with an average value of 777.6 m^2/day while transmissibility from Ewekoro hand-dug wells revealed values varying from 8.64 to 35,424 m^2/day with an average value of 7344 m^2/day; these values were found to be higher as compared to Ilorin basement complex that ranged between 7.184 and 447.954 m^2/day with an average of 49.12 m^2/day and Malawi basement of 2.0 to 35 m^2/day. The with average residual drawdown of 7.48m while the average Static Water Level (SWL) was 22.1m within a range of 4.41m to 48.1m, mean Specific Capacity (Cs) and Well Loss Constant (WLC) were 6.0×10^{-3} m^2/s and 0.616×10^{4} s^2/m^5 respectively with maximum Transmissibility (T) of 8.0×10^{-2} m^2/s (6912 m^2/day) for Ewekoro boreholes while the average residual drawdown of 0.93m and the average Static Water Level (SWL) was 2.04m within a range of 0.64m to 4.94m, mean Specific Capacity (Cs) and Well Loss Constant (WLC) were 6.2×10^{-2} m^2/s and 1.247×10^{4} s^2/m^5 respectively, with maximum Transmissibility (T) of 4.1×10^{-1} m^2/s (35,424 m^2/day) were recorded for Ewekoro hand-dug wells. The average recovery period of 2483 seconds (41.4 minutes) and average recovery period of 7961 seconds (132.7 minutes) were respectively recorded for Ewekoro boreholes and hand-dug wells. Borehole yields in the study area ranged between 2.864 $\times 10^{-2}$ litres/second and 5.747 $\times 10^{-2}$ litres/second with the lowest yield recorded around Agbesi, while the highest yield was recorded around Sapeti, alongside central Ewekoro. the yield from the hand-dug wells ranged between 5.721 $\times 10^{-3}$ litres/second at EWEWW15 around Ewekoro central and 60.976 $\times 10^{-3}$ litres/second at EWEWW22 around Akinbo while its specific capacity range from 3.126 $\times 10^{-3}$ m^2/s at EWEWW15 around Ikeja to 241.08 $\times 10^{-3}$

m^2/s at EWEWW4 around Agbesi Estate while the drawdown varies from 0.17m at EWEWW4 around Agbesi to 1.73m at EWEWW18 around Akinbo. Results from the two water sources in this study most specifically the transmissibility revealed that investigated aquifer in the study area possesses high groundwater potentials (>500 m^2/day) based on standard aquifer potentiality classification (Sen-Zekai, 2015) and the possibility of exploiting even the shallow aquifers for domestic uses as well as small-scale purposes where the demand for continuous use of public surface water supply is not met. There is availability of groundwater all over Ewekoro area that can support domestic use. For effective groundwater planning and development in the study area, it is recommended that; pre-drilling geophysical survey should be carefully conducted and test pumping must be carried out for economic and environmental purposes, groundwater exploration and overall development should be well monitored to avert depletion of groundwater potential zones and government should build storage reservoirs where the extracted groundwater resource could be stored for later distribution to encourage sufficient time for groundwater recharge.

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