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Research Article

Water Quality Assessment of Groundwater (Hand-Dug Wells) in Abeokuta North Local Government, Nigeria

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ABSTRACT

Groundwater is the major source of water for municipal use in the AbeokutaNorth Local Government of Nigeria. However, there is a tendency for its quality to deviate from recommended standards as most groundwater sources are close to regions prone to erosion and most well are not usually covered. The tragedy is that the adverse effect might creep into the ecosystem and affects humanity if a regular check on the quality is not been made. The Geographical location and altitude of each well location were taken using Global Positioning System (GPS). The moderate PH range (6.30-7.36) can be linked to low values of TDS (352 mg/L) and EC (695 ms/cm) which are within the standard recommended for drinking- indicate a low concentration of salt contents. The relationship between the parameters shows a direct trend with the hydraulic head. Hence, groundwater sources (wells) in Abeokuta North Local Government are good for drinking.

Keywords: Groundwater; Abeokuta North; Global Positioning System; PH; Total DissolvedSolid; Electrical conductivity; Hydraulic head; W.H.O

INTRODUCTION

Water is essential for sustainability of life; its continuous supply is important to improvise for the fluid lost during respiration, perspiration, and urination [1]. Among other places water can be found is beneath the soil, which is known as groundwater. Groundwater refers to water found in rocks and fractures beneath the earth. It includes all water found beneath the earth's surface. It is part of the earth's natural hydrological cycle. It is the body of water derived primarily from percolation and contained in pore spaces of a permeable rock [2].

It could be formed via natural precipitation from infiltration or indirectly from rivers, and it represents the water in the rocks and fissures of a particular geological formation [3]. The traditional method of obtaining groundwater in rural areas of the developing world, and still the most common, is by means of hand-dug wells. However, because they are dug by hand, their use is restricted to suitable types of ground such as clays, sands, gravels, and mixed soils where only small boulders are encountered. Some communities use the skill and knowledge of local well-diggers, but often the excavation is carried out, under supervision, by the villagers themselves. Also, leaching from waste dumps and industries makes them susceptible to contamination due to run offs into groundwater [4].

Water quality describes the physical, chemical, and microbiological characteristics of water. These properties collectively determine the overall water quality and the fitness of the water for a specific use. These properties are either intrinsic to the water or are the result of substances that are dissolved or suspended in the water. According to Annan [5], we cannot live without water and municipal activities can impact its quality and quantity. Fresh groundwater is associated with recharge areas, whilst groundwater is more mineralized.

The United Nation goal of access to safe drinking water especially in developing countries is frequently under threat due to an occurrence of pollutants such as radionuclides in drinking water which do pose a serious health hazard [6]. PH is one of the most important water quality parameters, although, it has no direct impact on consumers. Lower-PH water is likely to be corrosive. Corrosion can contaminate water and have adverse effects on its taste and appearance [7].

The PH in the range 6.5-8 is usually acceptable, although the nature of the construction materials used in the distribution system as well as the composition of the water both lower and increase this parameter [8]. In an extreme case, a surge the PH value could be because of accidental spills, treatment breakdowns and insufficiently cured cement mortar pipe linings, among others [9].

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In the same vein, over-mineralization of groundwater lowers water quality giving an objectionable taste, odor and excessive hardness [10]. Water contamination needs to be avoided because the quality of the water of the aquifer would be difficult to restore, afterward [11]. Aquifer source depth plays an important role in determining the thermal buffering capacity and waters quality ofgroundwater [12]. The depth and shallowness of groundwater also play important roles in land-use changes and surface contamination [13]. That said, the two factors tend to have different chemical properties [14].

Although, groundwater is naturally referring to as been safe for drinking. However, the quality does vary due to differences in associated rock type and within aquifers along groundwater flow paths [15]. Also, human activities might have effect on the water source overtime. Furthermore, according to UNDESA [16], the quality of surface or groundwater is depending on either or both the natural and human influences.

Therefore, periodic checking of the quality of groundwater is important to develop a strong database for future water resources strategic planning and development [17]. Many researchers have reported the quality of groundwater in different parts of Nigeria. However, no study has been conducted on the groundwater quality in Abeokuta North Local Government.

Well water is one of the major sources of water supply to the entire populace of Abeokuta North Local government and its environ, owing to the fact that, there is inadequate supply of pipe-borne water from the water works and boreholes. The boreholes found there are very scarce because it is expensive to construct when compared to the average standard of living of people living in the area. The geology formation of this Local government is the Basement Complex which is very difficult to drill due to the rocks beneath this formation.

This study, therefore, became necessary to ascertain the quality of the wells and Invariably its suitability for various purposes, to ensure the protection of the health of Users and determine liable sources of pollution. The information will be of great importance to relevant authorities. This study will serve as database for future research works in water quality assessment of Hand-dug wells in the Study area and influence decision making with regards to future groundwater development.

The wells located are not properly maintained due to lack of information of maintenance procedures like consistent closing of the cover, rinsing of the drawers before dipping inside wells, et cetera. Also, most wells in the study area are sited close to regions prone to erosion because of poor drainage system. The aim of this Novel research work is to measure and determine the Relationship between Electrical Conductivity (EC), Total Dissolved Solids (TDS), PH and Temperature in wells in Abeokuta North Local Government Area so as to ascertain whether or not the quality of water in this area is within standard recommended by World Health Organization.

MATERIALS AND METHODS

Materials Used: Rope,Distilled water, Toilet Roll, drawer, TDS/PH meter

DATA COLLECTION

Groundwater samples were collected and analysed in-situ (on site) from thirty-six (36) hand-dug wells around Abeokuta North Local government area. The Geographical location of all the wells was obtained using a GPS, the areas of location of each well was also recorded, and the time it was recorded was also obtained. The altitude of each location of the wells was also obtained using the GPS. The depth of the wells was obtained and the height of apron (ring above the ground surface). The depth of the well was gotten by immersing a Water drawer (rubber) inside the well and a pin is used to spot the location when the rope attached to the drawer starts sagging. The sagging of the rope indicates that the drawer has reached the bed. The measuring tape was then used in measuring the point located on the rope to the drawer and the readings taken and recorded.

The Temperature of the samples of water collected from the well was also obtained and this was done using the pH/TDS meter. The value obtained was recorded immediately after insertion to know the actual temperature of the water in that location because it varies depending on the location.

Groundwater samples taken from the wells were tested and analysed immediately after collection. The samples were analysed for explained below.

METHOD OF ANALYSING PHYSICOCHEMICAL PARAMETERS

PH

This is the measure of acidity/alkalinity of water. The Instrument for pH determination is PH/TDS meter. The water in the well was drawn and the pH meter to be used was first cleaned with distilled water to remove particles that may be have remained after the previous use. It was inserted inside the drawer with the water. Immediately after insertion there appears a clockon the surface of the meter indicating that the water is still been tested. The result obtained is being recorded immediately the clock disappears which shows that is the required result.

Electrical Conductivity

It is the measure of the dissolved ionic component in water, the latter which signifies the electrical properties[18]. The measurement was taken with the help of pH/TDS meter. The water in the well was drawn and the pH meter to be used was first cleaned with distilled water to remove particles that may have remained after the previous use. It was inserted inside the drawer with the water and immediately after insertion there appears a clock on the surface of the meter indicating that the water is still been tested. The result obtained is being recorded immediately the clock disappears which shows that is the required result.

Total Dissolved Solids

This represents the dissolved minerals or substances in water. It was measured with the help of PH/TDS meter. The water in the well was drawn and the pH meter to be used was first cleaned with distilled water to remove particles that may have remained after the previous use. It was inserted inside the drawer with the water and immediately after insertion there appears a clock on the surface of the meter indicating that the water is still been tested. The result obtained is being recorded immediately the clock disappears which shows that is the required result.

STUDY AREA

The Study Area is Abeokuta North Local government which lies on latitude 7°10´N and longitude 3°40´E and it has a landed area of 808 km2 (312 square miles). Its Headquarters is in the town of Akomoje near Abeokuta. It is bounded to the west by Yewa North Local government and to the east by Abeokuta South Local government and to the North by Odeda Local government and to the South by Ewekoro Local government. The average temperature and precipitation are 27.1 °C and 1238mm respectively(Figures 1 and 2) [19,20].

RESULTS AND DISCUSSIONS

The Table 1 represents the values obtained for the parameters under study for wells present in each subunit of the local government. The number of well varies from one region to the other (Figures 3-6).

Figure 1: Map of Nigeria showing Ogun State [19].

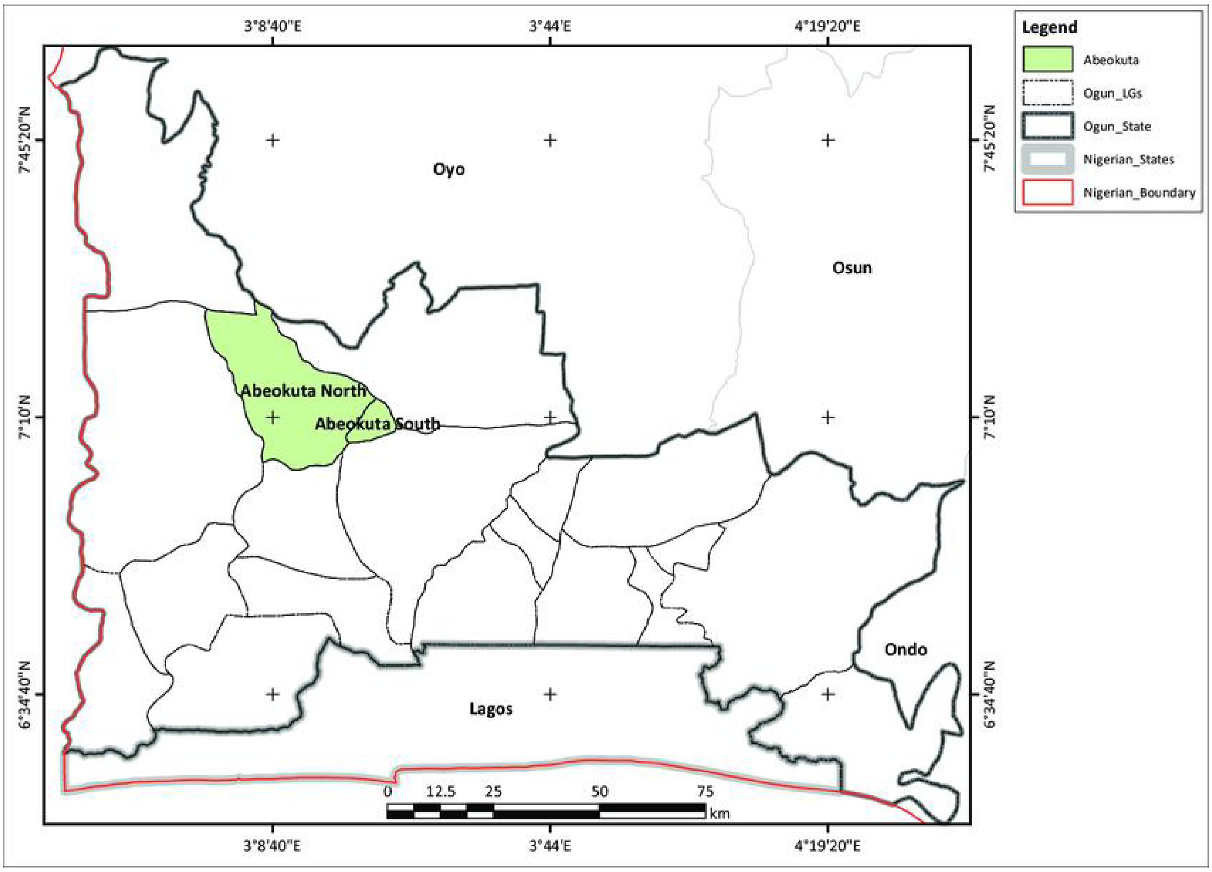

Figure 2: Map of Ogun State showing the area of interest [20].

Table 1: The results obtained for the water quality parameters.

S/N	X	LAT	LONG	ALT (m)	PH	TDS(ppm)	EC(ms/cm)	TEMP (‘c)	SWL (m)	TD (m)	H (m)	(Alt - SWL) (m)
1	SABO	3’19’ ’467	7’09” 455	64	6.53	480	953	26.8	2.41	5.5	1.2	61.59
2		3’19’ ’416	7’09” 450	64	6.35	394	798	28.5	3.42	3.5 2	0.46	60.58
3		3’19’ ’410	7’09” 418	64	6.74	466	932	27.3	1.56	2.9 4	0.14	62.44
4		3’19’ ’408	7’9”4 22	64	6.76	321	641	27.2	2.17	6.6 0	0.79	61.83
5		3’19’ ’423	7’09” 399	64	6.89	499	996	27.2	5.87	7.9 2	0.71	58.13
6		3’19’ ’419	7’09” 417	64	6.92	575	114 9	27	1.29	2.1 1	0.18	62.71
7	LAFE NWA	3’19’ ’524	7’09” 183	64	7.08	558	111 5	27.3	2.34	3,2 6	0.5	61.66
8		3’19’ ’530	7’09” 170	64	7.20	360	722	27.2	0.73	5.4 3	0.37	63.27
9		3’19’ ’528	7’09” 148	64	7.15	503	100 5	27.8	2.81	4.3 7	0.72	61.19
10		3”19 ”530	7’09” 144	64	7.10	496	987	28.6	1.12	3.2 1	0.19	62.88
11		3’19’ ’520	7’09” 085	64	7.00	472	945	27.4	1.38	4.5 4	0.75	62.62
12		3’19’ ’598	7’09” 144	64	7.19	381	757	27.8	3.24	4.3 1	0.52	60.76
13	TOTO RO	3’19’ ’978	7’09” 272	64	6.86	421	841	27.4	1.8	1.1 8	0.65	62.20
14		3’19’ ’923	7’09” 356	64	7.13	333	666	27.4	3.15	4.6 0	0.67	60.85
15	GBAG URA	3’20’ ’035	7”09’ ’356	64	7.05	430	857	26.8	1.12	2.0	0.18	62.88
16	IKER EDU IDAN	3’19’ ’770	7’09” 331	64	6.93	432	866	27.3	2.34	3.4 5	0.58	61.66
17		3’19’ ’772	7’09” 348	64	6.87	449	899	28.7	3.14	5.4 1	1.43	60.86
18	ITA-OSHIN	3’18’ ’307	7’08” 139	64	7.25	253	504	27.6	1.66	3.4 4	0.37	62.34
19		3’18’ ’339	7’08” 083	64	7.36	152	300	26.2	1.52	2.5 5	0.22	62.48
20		3’18’ ’358	7’08” 047	64	6.91	202	407	27.4	1.33	3.7 5	0.64	62.67
21		3’18’ ’374	7’08” 033	64	6.92	301	596	27.0	1.33	4.0 7	0.86	62.67
22		3’18’ ’409	7’08” 008	64	7.13	318	337	28.8	7.25	7.5 6	0.55	56.75
23		3’18’ ’355	7’07” 936	64	7.29	140	280	27.4	2.97	13. 05	0.61	61.03
24		3’18’ ’325	7’07” 934	64	7.04	212	425	27.4	0.29	3.3 1	0.72	63.71

25		3'18' '295	7'07'' 935	64	7.21	157	314	27.2	1.64	6.2 4	0.30	62.36
26	IBER EKODO	3'20' '298	7'11'' 031	62	6.95	389	773	26.0	2.74	4.0 0	0.00	59.26
27		3'20' '438	7'11'' 013	60	7.16	379	759	26.4	2.46	4.1 0	1.04	57.54
28		3'20' '438	7'11'' 013	60	7.17	350	696	26.9	2.65	4.2 8	1.25	57.35
29		3'20' '511	7'11'' 110	69	7.12	150	314	28.6	0.32	0.9 8	0.05	68.68
30		3'20' '508	7'11'' 130	63	7.09	242	485	28.4	1.11	2.1 4	0.82	61.89
31		3'20' '365	7'11'' 215	55	7.12	205	412	28.6	2.48	4.1 0	0.70	52.52
32	AKO MOJE	3'20' '350	7'11'' 293	49	7.10	250	506	27.8	2.12	3.2 5	1.21	46.88
33		3'20' '510	7'10'' 826	65	7.08	456	914	29.2	5.00	5,0 4	1.49	60.00
34	ELEG A	3'20' '800	7'11'' 024	94	7.16	340	680	28.7	3.70	4.8 7	1.00	89.13
35	AGO-ODO	3'20' '284	7'10'' 271	57	7.20	364	730	28.5	5.67	7.3 0	1.00	49.70
36		3'20' '382	7'10'' 401	42	7.12	255	450	28.2	2.23	2.5 1	0.78	39.49

Lat= Latitude; Long=Longitude; Alt= Altitude; TDS: Total Dissolved Solid; EC= Electrical Conductivity; SWL= Shallow Depth Length; TD= Total Depth; (Alt-SWL) = Hydraulic head; H= Height of Apron.

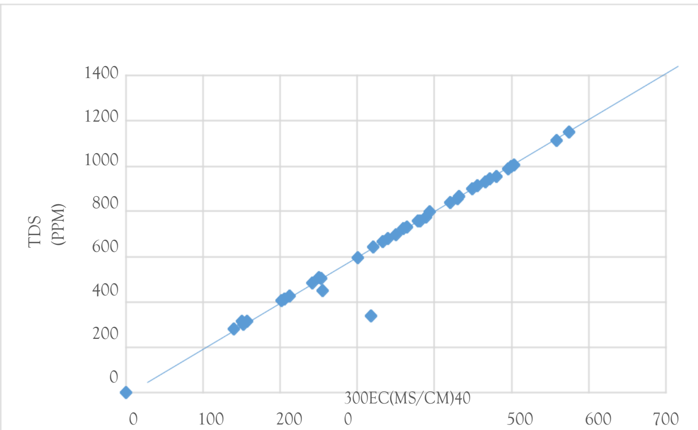

Figure 3: Graph of the Total Dissolved Solids (TDS) vs Electrical Conductivity (EC).

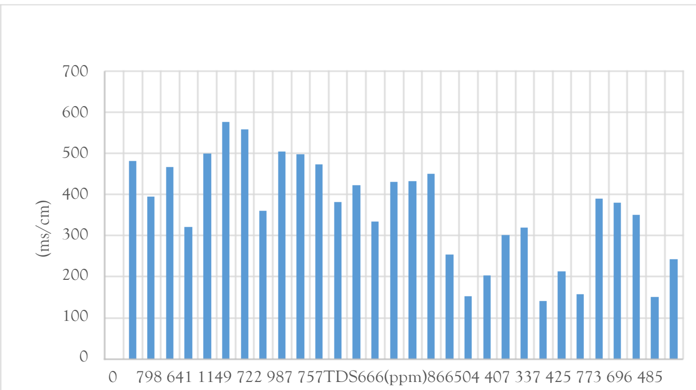

Figure 4: Graph of Electrical Conductivity (EC)vs Total Dissolved Solids (TDS).

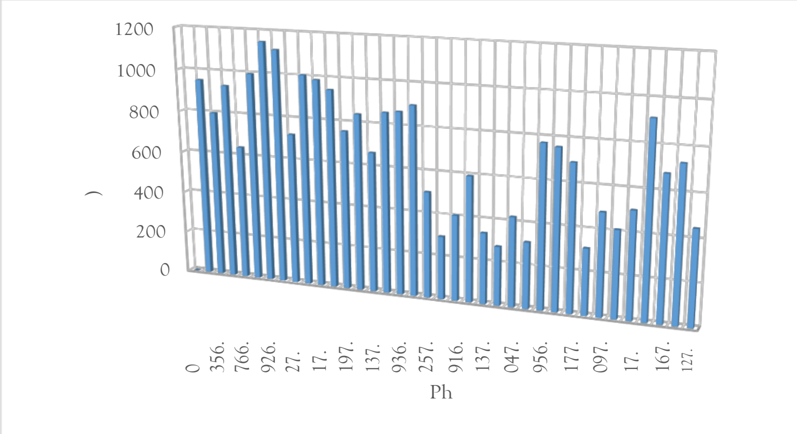

Figure 5: Graph of Electrical Conductivity (EC) against PH.

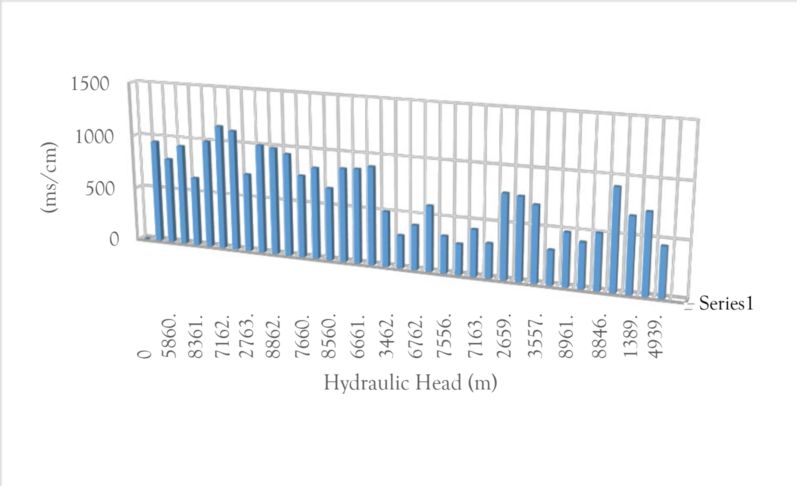

Figure 6: Graph of Electrical Conductivity (EC) against Hydraulic Head.

DISCUSSION

From the results obtained the relationship between conductivity and total dissolved solid TDS are observed as follows.

Temperaturevalues is not beyond what is expected of a tropical rain-forest region. It ranges from 26.0 to 29.2°C with an average of 27.6°C. This ambient temperature is good for consumption. It is important that the temperature is not too high, to prevent microbial growth, which might lead to unpleasant taste, odor, color, and corrosion issues [21].

It was observed that a straight-line graph was obtained; that is, increase in the Electrical conductivity led to an increase in the Total Dissolved solids found in the area. However, both the Total Dissolved Solid and Electrical Conductivity are within the World Health Organization's recommendation of 300-1200 mg/L and 500-1000 ms/cm respectively. The average values are approximately 352 mg/L and 695 ms/cm, in the same sequence. As a result, the water in the surveyed region can be said to have a relatively low salt concentration. This suggest a very minute solute dissolution, quick ion-exchange between the water and soil, or probably due to the presence of an insoluble rock and minerals [18]. The low value of TDS can be attributed to the mountainous characteristics of the area under study. Hence, it is for good for both human and animal consumption. The water samples meet the requirement of "fresh water" and can be used for irrigation purposes as this would not affect the osmotic pressure of soil solution, [22].

From the results obtained and shown in the graph it was discovered that relationship between EC and the hydraulic head shows a direct trend likewise with the PH.

The PH range from the results (6.30-7.36) is within the WHO recommendation for drinking water of 6.5-8.5. At 8.0 and above, might be of a disadvantage when an attempt to disinfect and treat such water source is made [21].

It shows and identifies that an increase in the EC gives rise to an increase in the PH and the hydraulic head. It was discovered that there was more increase in the Hydraulic head at a specific EC values in the area. This was also shown in the EC against the PH values obtained and Plotted [23-26].

The graph above certifies that there is a direct link between the PH, EC, TDS, and the Hydraulic head. The relationship and the evaluation conclude these parameters have a significant determination about quality of water that is available in an area. In the light of this, the above values correspond with World Health Organization recommendation for groundwater.

CONCLUSION

The quality of water obtained from the sampled wells in the study area does not differ significantly among themselves. This might be attached to the fact that the samples were taken in the same geographical locations and are prone to similar contaminations. Graph plotted shows that the relationship between the EC, TDS, PH, Hydraulic-Head parameters shows an insignificant

Positive correlation indicating increase in the parameters as the other increases, but all are within the recommendation of WHO standards for water quality. This can be interpreted to mean that groundwater sources (wells) in Abeokuta North Local Government are good for drinking.

RECOMMENDATIONS

From the study, the following recommendations could be prescribed for safe and healthy delivery of potable water.

- The well users should be conscious of adequate sanitation of the well and its environment like covering of the well and proper casing to improve the physical and chemical properties of the water.
- An impervious apron should be constructed around the well mouth to prevent seepage and intrusion of surface water from entering the well to provide a comparatively dry platform for the well users.
- Activities such washing, cooking must not be done around the well to prevent contamination.
- Stable and constant fetching equipment for abstraction must be assigned to every well to prevent contamination that occurs because of different fetching equipment being used by Individuals on the same well.

COMPETING INTERESTS

The authors declare no competing interest

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