International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 2, ISSN No. 2455-2143, Pages 17-25
Published Online June 2021 in IJEAST (http://www.ijeast.com)

DETERMINATION OF CONTAMINATION DISTANCE FOR BOREHOLES IN OKIGWE ZONE, IMO STATE NIGERIA

Uchendu E.E,
Department Of Agric. Engineering
Federal Polytechnic Nekede
Imo State, Nigeria

Madubuike C.N, Okereke C.D, Okereke N.A.A
Department Of Agric. Engineering
Federal University Of Technology Owerri
Imo State, Nigeria

ABSTRACT - Groundwater contaminants in Okigwe zone in Imo state made up of six local government areas were investigated. Four (4) groundwater samples were collected from each local government area. This amounted to twenty-four groundwater samples. These samples were collected randomly from sites close to septic tanks and to avoid contamination from tanks, the samples were collected at the well head, before water enters into storage tanks. The samples were stored in a sterilized 250 ml bottles and then taken to the laboratory for analysis. The chemical parameters were determined using a HA-CH 44600-00 and using standard methods as contained in Chessbourgh (2014). These samples were refrigerated and analyzed within 24 h. All plastics and glass wares utilized were pre-washed with detergent water solution, rinsed with tap water and soaked for 48 h in 50% HNO3 then rinsed thoroughly with distilled- deionized water. These results were used to ascertain the levels of groundwater contamination in Okigwe zone. An equation was generated from the chemical parameters using SPSS and E-view softwares to estimate the minimum allowable distance for locating borehole from sources of contamination in Okigwe zone in Imo state Nigeria. The minimum allowable distance calculated for groundwater from sources of contamination (septic tanks) is 15.81meters.

Keywords: Groundwater, Pollution, Contaminants, Septic tank

I. INTRODUCTION

Groundwater is important for livelihood even for the socioeconomic development of an environment. Nickson et al. (2005) established that approximately one third of the world's population use groundwater for drinking, domestic and industrial purposes. More than 70% of the wastes generated in Imo state are discharged into the environment without any form of treatment. These wastes are dissolved by precipitation and irrigation water and produce contaminants which infiltrate into the soil and end up into the aquifers. Others flow through the surface water into the groundwater and start circulating from there. Once contaminated, it is difficult, if not impossible, for the water quality to be restored not even by stopping the pollution from source (Remarkrishnaiah et al., 2009). Ijeh and Onu (2013) showed that the deterioration of groundwater quality in Imo state can be attributed to pollution from anthropogenic and natural sources. Nwachukwu (2014) showed that most dumpsites are usually haphazardly located without careful consideration of environmental and public health.

Hundreds of people die every year from water borne diseases. The rate of deaths recorded over the last ten years in Imo state has given rise to scrutinizing the level of water quality in the state. Human activities have contributed in no small measure to the pollution of groundwater and have become less suitable for drinking, domestic and agricultural purposes. Indiscriminate dumping of refuse has deteriorated the ecosystem and the environment.

The sources of these wastes include food processing preservations, dumpsites, septic tanks, acid water recharge, abattoirs, urban runoff, oil spillage, pesticides, insecticides, herbicides, fertilizers, condemn batteries, dry cleaning chemicals, cemeteries, urine and hospital wastes**.** The presents of these contaminants in groundwater has caused so many water borne diseases like cholera, typhoid and hepatitis. Kidney disease, cancer of skin, bladder and lung diseases, neurological disorder, muscular weakness, pigmentation changes, skin thickening, loss of appetite and nausea may result from consuming contaminated water (Feachen *et al.*, 1998). The trend may jeopardize the global zest towards millennium development goal of health for all, if unchecked. There is need for proactive action both at national and international levels to restore the quality of groundwater and be able to sustain and transfer to the next generation. Waste management to avoid contaminating both surface and subsurface water should be a global concern and regular check of water quality should be paramount in this 21st century. . Treatment of pollution these days are multifaceted in that new emerging pollutants are being discovered every year. Old treatment methods may no longer be effective to combat these pollutants. Conventional methods for removing groundwater contaminants are either becoming inadequate to meet current stringent regulatory effluents limit or are increasing in cost (Ragasulocham and Prealthy, 2016).

II. MATERIALS AND METHODS

Twenty-four groundwater samples were collected from boreholes located around the Okoigwe zone Imo state, South Eastern Nigeria. The samples were stored in a sterilized 250 ml bottles and then taken to the laboratory for analysis. The chemical parameters were determined using a HA-CH 44600-00 using standard methods as contained in Chessbourgh (2014). These samples were refrigerated and analyzed within 24 h. All plastics and glass wares utilized were pre-washed with detergent water solution, rinsed with tap water and soaked for 48 h in 50% HNO3 then rinsed thoroughly with distilled-deionized water. These results were used to ascertain the levels of groundwater contamination in Okigwe zone. An equation was generated from the chemical parameters using SPSS and E-view softwares to estimate the miniimum allowable distance for locating borehole from sources of contamination in Okigwe zone in Imo state Nigeria. The minimum allowable distance calculated for groundwater from sources of contamination is 15.81meters. The result showing possible sources of contaminants was shown in Table 1. They were then air-dried in a dust free environment. The results were presented in Table 2.

III. RESULTS AND DISCUSSION

The results of groundwater chemical parameters for Okigwe zone in Imo state were shown in table 2. The Table below shows the values of borehole water samples and their distances from possible sources of contamination. The distances are in meters measured with the help of a meter rule. The lowest value is 12m and the highest value is 34m.

Table 1: Borehole Water Samples and Their Distances from Possible Sources of Contamination.

LGA	Area	Distance from closet potential source of contamination (m)	Closest source of contamination.
Ehime Mbano	Umuezeala	28	Septic tank
	Umueze II	19	Septic tank
	Agbja	14	Septic tank
	Umunakuru	28	Septic tank
Isiala Mbano	Anara	12	Septic tank
	Amaraku	17	Septic tank
	Ugiri	25	Septic tank
	Umunkwo	20	Septic tank
Onuimo	Umuduru	32	Septic tank
	Okwe	28	Septic tank
	Okwelle	15	Septic tank
	Umuopara	17	Septic tank
Obowo	Umunachi	20	Septic tank
	Achingala	34	Septic tank
	Avutu	20	Septic tank
	Alaike	22	Septic tank
Ihitte Uboma	Isinwaeke	12	Septic tank
	Amakohia	31	Septic tank
	Umuihi	20	Septic tank
	Aboeke	33	Septic tank

Okigwe	Ope	24	Septic tank
	Ubahaa	30	Septic tank
	Umuka	20	Septic tank
	Umuokpara	18	Septic tank

The Table below shows the values of chemical values from selected boreholes in Okigwe zone. The chemical parameters are Ca, Zn, Pb, Fe, Mg, Na, SO_4, PO_4, Ci, and NO_3. The second row of the Table 2 shows the world Health Organization (WHO) and Nigeria Standard for Drinking Quality Water (NSDQW) permissible values for comparison of results.

Table 2: Chemical Parameters Values of Sample before Treatment

LGA	Sample Loc	Ca	Zn	Pb	Fe	Mg	Na	SO_4	PO_4	CI	NO_3
	WHO NSDQW	200 200	5.0 5.0	10.µg 10.µg	0.3 0.3	50 50	200 200	250 100	10 5	250 250	50 10
Ehime	Umuezeala	41.2	0.8	Nil	0.43	3.43	2.48	3.5	5.0	12.4	7.0
	Umueze II	57.8	0.7	Nil	0.29	5.04	Nil	5.1	2.8	11.7	3.5
	Agbja	53.4	0.6	Nil	0.8	0.04	1.55	2.6	2.3	9.3	4.6
	Umunakuru	39.6	1.1	0.02	0.22	2.02	1.59	Nil	3.4	7.6	5.9
Isiala	Anara	33	1.2	0.02	0.42	3.2	2.34	Nil	3.6	12.5	11.8
	Amaraku	35.2	1.1	Nil	0.38	2.9	2.32	11.9	5.1	5.4	3.8
	Ugiri	37.8	0.8	0.15	0.2	1.28	Nil	12.7	4.8	6.3	2.7
	Umunkwo	40.8	0.7	Nil	0.4	1.39	2.04	2.1	1.7	6.8	4.0
Ihitte	Isinwaeke	41.8	0.8	Nil	0.9	2.44	4.05	Nil	3.3	6.7	4.8
	Amakohia	53.4	1.2	0.015	0.8	1.82	2.84	12.6	Nil	8.2	3.7
	Umuihi	37	1.4	Nil	0.45	3.04	Nil	13.2	4.4	7.9	4.4
	Aboeke	38.6	1.0	Nil	0.32	4.31	1.96	14.1	3.4	8.8	5.7
Okigwe	Ope	29.2	0.8	Nil	0.4	2.43	1.34	6.7	Nil	10.3	6.8
	Ubahaa	57.8	1.7	Nil	0.3	6.42	1.83	12.4	2.6	14.5	11.0
	Umuka	65.4	1.8	Nil	0.38	4.31	Nil	4.2	3.1	8.2	8.7
	Umuokpara	39.2	2.0	Nil	0.46	2.4	2.37	Nil	5.0	9.0	6.3
Obowo	Umunachi	37.2	0.7	Nil	0.77	4.09	Nil	3.6	4.4	7.2	4.8
	Achingala	38.4	1.1	Nil	0.16	3.05	2.02	6.3	Nil	4.6	3.7
	Avutu	42.6	1.0	Nil	0.36	1.84	3.12	2.4	3.2	17.4	3.7
	Alaike	44.8	0.7	Nil	0.38	3.24	3.41	13.2	Nil	8.2	7.2
Onuimo	Umuduru	40.2	0.7	Nil	0.4	1.85	3.23	2.9	Nil	6.4	5.2
	Okwe	42.4	0.5	Nil	0.32	1.04	4.01	11.8	2.6	5.6	3.2
	Okwelle	32.2	0.6	Nil	0.3	2.05	2.01	2.7	3.8	6.2	7.2
	Umuopara	34.6	1.0	Nil	0.29	1.06	Nil	3.6	4.7	4.8	6.3

All units are in mg/I except where stated.

Table 3 shows the treatment of these water samples with permeable reactive barrier filtration materials. The second row is for the comparison with WHO and NSDQW.

Table 4. Descriptive Statistics and Normality Test value for chemical parameters

	CA	CL	CONTD	FE	MG	NA01	NO3	PB	PO4	SO4	ZN
Mean	149.644	27.52000	83.88889	1.323333	9.799630	9.159259	21.88519	0.030185	11.91111	25.74111	4.107407
Median	146.8000	27.86000	85.00000	1.190000	9.740000	8.710000	21.00000	0.020000	11.60000	24.50000	3.900000
Maximum	222.6000	45.30000	124.0000	2.900000	15.56000	14.62000	43.50000	0.150000	25.40000	51.90000	6.300000
Minimum	99.40000	9.850000	50.00000	0.700000	5.600000	5.540000	12.00000	0.000000	6.700000	8.300000	2.800000
Std. Dev.	31.62060	9.673008	16.46753	0.523391	2.371690	2.443053	6.398059	0.032713	3.440520	10.15592	0.957933
Skewness	0.336825	-0.050166	0.213393	1.415539	0.277345	0.641003	1.402798	1.969509	2.160217	0.623054	0.700645
Kurtosis	2.460619	2.172407	3.148471	4.723522	2.942238	2.916760	6.193488	7.752920	9.973975	3.136588	2.896573
Jarque-Bera	0.837829	0.781848	0.229713	12.35872	0.349894	1.856778	20.32845	42.86937	75.71528	1.767871	2.221098
Probability	0.657760	0.676432	0.891494	0.002072	0.839501	0.395190	0.000039	0.000000	0.000000	0.413154	0.329378
Sum	4040.400	743.0400	2265.000	35.73000	264.5900	247.3000	590.9000	0.815000	321.6000	695.0100	110.9000
Sum Sq. Dev.	25996.43	2432.744	7050.667	7.122400	146.2477	155.1812	1064.314	0.027824	307.7667	2681.708	23.85852
Observations	27	27	27	27	27	27	27	27	27	27	27

From Table 4, it could be seen that the data is not normally distributed as the mean values of the variables are so dispersed from each other in value. Their probability values show an unstable conclusion about their normality as well as the fact that some are less than 0.05 and others are greater than 0.05. To validate the normality assumption, we take an examination of the histogram normality test below.

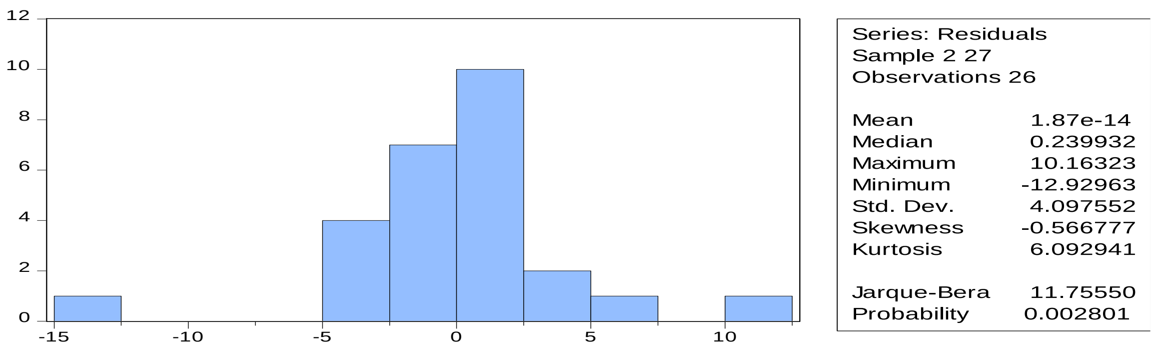

Figure 1 Histogram Normality Test **(Source: E-views 10 Regression output.)**

From the data above, the probability value (0.002801) was less than 0.05; hence the sample data does not satisfy normality distribution assumption as corroborated above.

Table 5 Stationarity (Unit Root) Test.

Variables	Adf Stat. (level)	5% Critical value	Adf Stat.(1stdiff)	5% Critical value	Remark
CA	-4.935302*	-3.711457	-9.669154	-2.986225	I(0)
CL	-4.279067*	-2.981038	-6.721036	-2.986225	I(0)
CONTD	-2.514514	-2.981038	-6.343421*	-2.986225	I(1)
FE	-3.524563*	-2.981038	-5.640724	-2.986225	I(0)
MG	-4.185471*	-2.981038	-7.543754	-2.986225	I(0)
NA01	-3.384307*	-2.981038	-6.718346	-2.986225	I(0)
NO3	-4.088000*	-2.981038	-8.629529	-2.986225	I(0)
PB	-3.533289*	-2.981038	-6.594760	-2.986225	I(0)
PO4	-3.990872*	-2.981038	-8.731717	-2.986225	I(0)

SO4	-5.972007*	-2.981038	-11.07675	-2.986225	I(0)
ZN	-4.623217*	-2.981038	-7.662919	-2.986225	I(0)

Source: Researcher's compilation from E-views 10 Regression output.

The Asterisks (*) is used to indicate stationarity at the 5% level of significance.

From the stationarity test Table 4, only contamination distance (CONTD) achieved stationarity at first difference while; CA, CL, FE, MG, NA, NO3, PB, PO4, SO4 and ZN were stationary at level. Owing to the mixed order of stationarity, the Auto-regressive Distributed Lag (ARDL) model of estimation was adopted for further analysis.

Table 6. Correlation of Parameters

	CONTD	CA	CL	FE	MG	NA01	NO3	PB	PO4	SO4	ZN
CONTD	1	0.0335	0.2952	0.088	0.3052	-0.326	-0.1088	-0.2891	-0.1183	-0.1312	0.1241
CA	0.0335	1	0.0532	0.3373	-0.0866	0.1746	-0.0473	0.2663	0.4018	0.0923	-0.2455
CL	0.2952	0.0532	1	0.2729	0.3549	-0.5619	0.1993	-0.1298	-0.4438	-0.366	0.1693
FE	0.088	0.3373	0.2729	1	0.2244	-0.1598	0.0547	-0.1057	0.0183	-0.1919	-0.2533
MG	0.3052	-0.0866	0.3549	0.2244	1	-0.438	0.1739	-0.1379	-0.3196	-0.1271	0.3227
NA01	-0.326	0.17466	-0.5619	-0.1598	-0.438	1	-0.3254	-0.1037	0.3722	0.3539	-0.2851
NO3	-0.1088	-0.0473	0.1993	0.0547	0.1739	-0.3254	1	-0.0631	-0.2629	-0.0266	0.3216
PB	-0.2891	-0.2663	-0.1298	-0.1057	-0.1379	-0.1037	-0.0631	1	-0.0994	0.0176	-0.1393
PO4	-0.1183	0.4018	-0.4438	0.0183	-0.3196	0.3722	-0.2629	-0.0994	1	-0.0764	0.0508
SO4	-0.1312	0.0923	-0.366	-0.1919	-0.1271	0.3539	-0.0266	0.0176	-0.0764	1	-0.0471
ZN	0.1241	-0.2455	0.1693	-0.2533	0.3227	-0.2851	0.3216	-0.1393	0.0508	-0.0471	1

From the Table 6, it can be seen that CA, CL, FE, MG and ZN have positive, but weak correlation with contamination distance as shown by their respective coefficients of 0.0335, 0.2952, 0.0880, 0.3052 and 0.1241.

On the other hand, NA01, NO3, PB, PO4 and SO4 have negative, but weak correlation with contamination distance as shown by their respective coefficients of-0.3260, -0.1088,-0.2891,-0.1183 and -0.1312.

Table 7 Parameters Output Estimation

Dependent Variable: (CONTD)
METHOD: ARDL
Dependent lags: 1 (Fixed)
Dynamic regressors (1 lag, fixed):
CA CL MG FE NA01 NO3 PB PO4 SO4 ZN
Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CONTD(-1)	0.704701	0.234379	3.006677	0.0397
CA	0.147777	0.127021	1.163412	0.3093
CA(-1)	0.120883	0.143702	0.841208	0.4476
CL	-1.194751	0.547932	-2.180472	0.0947
CL(-1)	-0.098453	0.415641	-0.236870	0.8244
MG	-1.619665	1.572963	-1.029690	0.3613
MG(-1)	-0.220989	1.231126	-0.179502	0.8663
FE	-13.31849	7.615823	-1.748792	0.1552
FE(-1)	13.93407	9.300646	1.498183	0.2084
NA01	-0.185105	1.387117	-0.133445	0.9003
NA01(-1)	-3.971675	1.730264	-2.295416	0.0834
NO3	0.160229	0.606051	0.264383	0.8045
NO3(-1)	-1.406493	0.707507	-1.987957	0.1177
PB	-292.6341	96.25526	-3.040188	0.0384
PB(-1)	-246.3712	130.1107	-1.893550	0.1312

International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 6, Issue 2, ISSN No. 2455-2143, Pages 17-25
Published Online June 2021 in IJEAST (http://www.ijeast.com)

PO4	-1.466277	1.331024	-1.101616	0.3325
PO4(-1)	-3.645375	1.699118	-2.145451	0.0985
SO4	0.277098	0.362318	0.764792	0.4870
SO4(-1)	-0.170232	0.372139	-0.457443	0.6711
ZN	-6.788680	5.656026	-1.200256	0.2963
ZN(-1)	-0.906122	4.022297	-0.225275	0.8328
C	211.4209	63.42219	3.333547	0.0290

R-squared	0.940456	Mean dependent var	83.84615
Adjusted R-squared	0.627850	S.D. dependent var	16.79212
S.E. of regression	10.24388	Akaike info criterion	7.311744
Sum squared resid	419.7484	Schwarz criterion	8.376287
Log likelihood	-73.05267	Hannan-Quinn criter.	7.618294
F-statistic	3.008440	Durbin-Watson stat	2.822187
Prob(F-statistic)	0.146970		

*Note: p-values and any subsequent tests do not account for model selection.

Table 8. Cointegration Test

F-Bounds Test Null Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	2.11	10%	1.76	2.77
K	10	5%	1.98	3.04
		2.5%	2.18	3.28
		1%	2.41	3.61

From the Table 8 above, it can be seen that there is no long run relationship in the model, but rather a short run phenomenon since the F-statistic value of 2.11 is greater than the I(0) value, but less than the I(1) value; hence the absence of long run relationship in the model as revealed by the Bounds test.

Table 9: Statistical derivation of contamination distance using SPSS and E-View.

Dependent Variable: (CONTD)
Selected Model: ARDL(1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1)
Case 2: Restricted Constant and No Trend
Date: 08/12/20 Time: 15:27
Sample: 1 27
Included observations: 26

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CA)	0.147	0.031	4.642	0.0097
D(CL)	-1.194	0.154	-7.72	0.0015
D(FE)	-13.318	2.065	-6.44	0.0030
D(MG)	-1.619	0.431	-3.75	0.0199

D(NA01)	-0.185	0.476	-0.38	0.7177
D(NO3)	0.160	0.173	0.921	0.4089
D(PB)	-292.63	41.06	-7.12	0.0020
D(PO4)	-1.466	0.417	-3.50	0.0247
D(SO4)	0.277	0.113	2.440	0.0712
D(ZN)	-6.788	1.220	-5.56	0.0051
CointEq(-1)*	-0.295	0.030	-9.75	0.0006

R-squared	0.928	Mean dependent var	0.076
Adjusted R-squared	0.881	S.D. dependent var	15.34
S.E. of regression	5.289	Akaike info criterion	6.465
Sum squared resid	419.7	Schwarz criterion	6.997
Log likelihood	-73.0	Hannan-Quinn criter.	6.618
Durbin-Watson stat	2.822		

* p-value incompatible with t-Bounds distribution.

The prediction model for calculating effect of distance from contaminants is obtained as follows:

$$D(CONTD) = 0.147D(CA) - 0.194D(CL) - 13.318D(FE) - 1.619D(MG) + 0.160D(NO3) - 292.63D(PB) - 1.466D(PO4) + 0.277D(SO4) - 6.788D(ZN) - 0.295\,CointEq(-1)*^{*} \qquad 1$$

Substituting the parameters into equation 1, we obtain the value for the minimum allowable distance for locating a borehole from a septic tank as shown below.

Table 10 below shows the values of distance when these chemical parameters were substituted in the predicting model (equation 1). It can be seen that the lowest value is 9.214 at Isiala Mbano while the highest is 26.19 at Okigwe LGA. The overall mean or average of these distances shows that 15.81m is the minimum value for location of septic tank near boreholes in Okigwe zone.

Table 10: Computation of Contamination Distance for Okigwe zone

LGA	Ca	Zn	Pb	Fe	Mg	Na	SO4	PO4	CL	NO3	Distance	ABS(D)
Ehime	41.2	0.8	0	0.43	3.43	2.48	3.5	5	12.4	7	-18.6	18.6
	57.8	0.7	0	0.29	5.04	0	5.1	2.8	11.7	3.5	-12.97	12.97
	53.4	0.6	0	0.8	0.04	1.55	2.6	2.3	9.3	4.6	-10.96	10.96
	39.6	1.1	0.02	0.22	2.02	1.59	0	3.4	7.6	5.9	-19.51	19.51
Isiala	33	1.2	0	0.16	3.05	2.02	6.3	0	4.6	3.7	-9.214	9.214
	35.2	1.1	0	0.38	2.9	2.32	11.9	5.1	5.4	3.8	-16.96	16.96
	37.8	0.8	0.15	0.2	1.28	0	12.7	4.8	6.3	2.7	-28.11	28.11
	40.8	0.7	0	0.4	1.39	2.04	2.1	1.7	6.8	4	-9.216	9.216
Onuim	40.2	0.7	0	0.4	1.85	3.23	2.9	0	6.4	5.2	-7.066	7.066
	42.4	0.5	0	0.32	1.04	4.01	11.8	2.6	5.6	3.2	-4.519	14.519
	32.2	0.6	0	0.3	2.05	2.01	2.7	3.8	6.2	7.2	-11.82	11.82
	34.6	1	0	0.29	1.06	0	3.6	4.7	4.8	6.3	-13.39	13.39
Obow	37.2	0.7	0	0.77	4.09	0	3.6	4.4	7.2	4.8	-22.54	22.54
	38.4	1.1	0	0.42	3.2	2.34	0	3.6	12.5	3.7	-20	20
	42.6	1	0.02	0.36	1.84	3.12	2.4	3.2	17.4	11	-20.09	20.09
	44.8	0.7	0	0.38	3.24	3.41	13.2	3.4	8.2	7.2	-10.53	10.53
Ihitte	41.8	0.8	0	0.9	2.44	4.05	0	3.3	6.7	4.8	-20.89	20.89
	53.4	1.2	0.01	0.8	1.82	2.84	12.6	0	8.2	3.7	-16.09	16.09
	37	1.4	0	0.45	3.04	0	13.2	4.4	7.9	4.4	-18.9	18.9
	38.6	1	0	0.32	4.31	1.96	14.1	3.4	8.8	5.7	-14.52	14.52
Okigw	29.2	0.8	0	0.4	2.43	1.34	6.7	0	10.3	6.8	-9.749	9.749

	57.8	1.7	0	0.3	6.42	1.83	12.4	2.6	14.5	11.5	-19.08	19.08
	65.4	1.8	0	0.38	4.31	0	4.2	3.1	8.2	8.7	-18.52	18.52
	39.2	2	0	0.46	2.4	2.37	0	5	9	6.3	-26.19	26.19
$\sum_{i}^{n} \mathbf{D}$											-379.434	379.434
$\frac{\sum_{i}^{n} \mathbf{D}}{\mathbf{n = 24}}$											-15.81m	15.81m

Base on the lowest value and highest value and their results, it can be seen that the results have significant difference as shown below for chemical parameters. The values for Pb and nitrate for the two samples before treatment were 0.02, 11.8, and Nil, 3.7 respectively. This shows that the nearer the borehole is to the septic tank the chances of contamination is higher and vice versa.

The chemical parameters values for calcium, magnesium, sodium and zinc were within permissible limits. Lead (Pb) contaminations with values ranging between 0.015 to 0.04 were observed which were above 0.01mg/l standard permitted by NSDQW and WHO for portable drinking water. Lead contamination has been reported to have adverse health implication which includes cancer, vitamin D metabolism interference, impairment of proper infant mental development, toxicity to the central and peripheral nervous systems (NSDQW, 2007). Foster *et al*., (2002) reported associated lead contamination source as also possible from septic tanks and pit latrine. Iron contamination with values higher than 0.3mg/l were recorded which could be as a result of steel pipes. The possible health effects are high concentration of iron stored in the pancreas, liver, spleen (Oteze, 1991). High concentration of iron in the body can cause liver and lung problems (Offodile, 1987). Values of sulphate below the WHO and NSDWQ stipulated levels were observed in all the samples. High levels of sulphate in drinking water can lead to dehydration and diarrhea especially in children (NSDWQ, 2007). It can also cause noticeable taste and very high levels might cause laxative effect in unaccustomed consumers. Phosphate are not toxic to people or animals unless when they are present in very high levels.

Longe and Balogun (2010) associated high phosphate levels in ground water as due to landfill operations and fertilizer application on farm lands. Excess chloride can be dangerous to the health of both humans and farm animals. Some samples show nitrate values that exceed the recommended value of 10mg/l by WHO. Nitrate could come from municipal and industrial waste water including leach from waste disposal system (Foster *et al*., 2002). High nitrate concentrations have detrimental effects on infants less than 3.6 months of age and can also lead to blue baby disease or syndrome which threatens the oxygen carrying capacity of the blood around the body (Chapman, 1996).

Tables 3 to 5 show increase of some chemical parameters' like calcium, iron, magnesium, sodium, phosphate etc after treatment. On the contrary, values of zinc, sulphate, nitrate and lead were reduced significantly from their original values after treatment. These observations correspond to the views of Luca (2007).

The minimum allowable distance between septic tank and borehole for contaminants was calculated to be 15.81metres. This means that in Imo state, it is safe to site borehole at a distance from 15m and above from septic tanks. This conforms to standard engineering practice.

IV. CONCLUSION

The overall importance of this study is that it is no longer speculation that Imo state groundwater needs some levels of treatment before use /consumption. The level of treatment has passed use of net and alum. The three treatment methods were able to treat the samples with different degrees of efficiency. Some samples reduced in concentration while some increased in concentration. There are heavy consequences of ignoring the health implication of Imolites by paying less attention to regulation of drinking water. The minimum distance for location of borehole from septic tank is 15.81m from the prediction model.

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