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Leachate Contamination of Groundwater from Dumpsites in Effurun and Environs, Delta State, Nigeria

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ABSTRACT

Groundwater study was carried out in Effurun and environs to determine leachate contamination of water. One leachate sample and two bore-hole water samples were collected from three different locations. The samples were analysed using internationally acceptable method, the analysed parameters include pH, Total Dissolved Solids (TDS), Conductivity, Temperature, Calcium, Magnesium, Iron, Lead, Cadmium, some major anions (Nitrate, Sulphate, Chloride, Phosphate) and Total Coliform Count.The major cation concentrations determined were in the order of Ca^{2+}> Mg^{2+}>$Fe^{2+}$with mean values of 4.2mg/l, 1.59mg/l, and 1.17mg/l, respectively and those of the major anion concentration of the water is of the order Cl^{-} > SO_4^{2-}> NO^{3-}> $PO_4^{3-}$with mean values of 24.45mg/l, 6.81mg/l, 2.58mg/l and 1.88mg/l respectively. This study also revealed the health implication of some of the parameters that are of higher concentration in the water and as such higher than the permissible limit set aside by SON and WHO standards. The result of the pH indicates the presence of metals in the samples particularly toxic metals such as Lead, Cadmium and Iron. Due to the high levels of chemical and bacteriological

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contamination of water from the boreholes, health problems as typhoid fever, worm infestation are imminent when such water is consumed in its present state.

(I) INTRODUCTION

Water is important as many aspects for human survival and other living organism. Fresh water is essential for their healthy growth; otherwise contaminated water will be source of various health issues (Kendall, 1992). In many metropolitan cities, open, uncontrolled and poorly managed dumping is commonly practiced, giving rise to serious environmental degradation. More than 90% of municipal solid waste in cities and towns are directly disposed-off on land in an unsatisfactory manner and often pose a threat to ground water quality and has resulted in many incidents of ground water contamination in Effurun, Delta state. Nearly all human activities generate waste, and the way in which this is handled, stored, collected and disposed of, can pose risks to the environment and to public health (Zhu et al., 2008). Landfills or dumpsites have been identified as one of the major threats to groundwater resources (Fatta et al., 1999; USEPA, 1984;).

The dumped solid wastes gradually release its initial interstitial water and some of its decomposition by-products get into water moving through the waste deposit. Such liquid containing innumerable organic and inorganic compounds is called “leachate”. This leachate accumulates at the bottom of the landfill and percolates through the soil. Areas near landfills have a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby site. Such contamination of groundwater resource poses a substantial risk to local resource user and to the natural environment. Many approaches have been used to evaluate the contamination of underground water. It can be measured either by the experimental determination of the impurities or their estimation through mathematical modeling (Moo-Young et al., 2004; Hudak, 1998; Stoline et al., 1993; and Butow et al., 1989). In the present study, the impact of leachate percolation on groundwater quality was estimated from three unlined waste dumpsite site namely Osubi Dumpsite, Niger – CAT Dumpsite and Mofor Dumpsite in Effurun, Delta state.

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The leachate and water samples were analyzed for various physico-chemical parameters like pH, Electrical Conductivity (EC), Temperature, Total Dissolved Solids (TDS), Chemical Oxygen Demand (COD), Biochmical Oxygen Demand (BOD_5), Turbidity, Sulphate (SO_4^{2-}), Phosphate (PO_4^{2-}), Chloride (Cl^-), Nitrate (NO_3^-), Calcium (Ca), Magnesium (Mg), iron (Fe), cadmium (Cd) and lead (Pb). Microbial analysis was also carried out on Total Coliform Count (TCC) present in the water. Both leachate and groundwater samples were analyzed in order to understand the possible link of groundwater contamination. Various remedial measures were discussed in order to reduce the concentration of pollutants in the groundwater.

(II) AIM AND OBJECTIVES

This work is aimed at determining the physiochemical composition of leachates from dumpsites and groundwater in Effurun and its environs through digital analysis using Oakton Multi-Parameters equipment to measure the physical parameters such as pH, temperature, Total Dissolved Solids (TDS) and conductivity in the field, laboratory analysis to determine other physiochemical parameters and microbial analysis to know the amount of coliform count in the water, the health impact of the leachate contamination in the groundwater to humans and recommending remedial controls

LOCATION AND ACCESSIBILITY

The study area (with locations including Osubi, Niger – CAT and Mofor) lie within the Niger Delta of Nigerian sedimentary basin whichis characterized by both marine and mixed continental quaternary sediments that are composed of abandoned beach ridges and mangrove swamps (Allen, 1999). The area is bounded by latitude $05^0 31'$ and $05^0 48'$ N, and longitude $05^0\ 45'$ and $06^0\ 08'$ respectively.

The study area is accessible by both major Federal Government roads and also by smaller state roads. Footpaths are rarely used except in the fringes of the study area where urbanization is still lacking. Public transportation is however available throughout the study area.

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(III) METHODOLOGY

MATERIALS AND METHODS

This chapter discusses the field procedure and precaution of sample collection and also the analysis carried out in-situ (on the field) at the sampling point e.g., pH, temperature, total dissolved solids (TDS) and conductivity using Oakton Multiparameters equipment.

Table 1: Showing sampling parameters

STUDY AREA	SYMBOL	DESCRIPTION	LOCATION COORDINATES & ELEVATION	AGE OF DUMPSITE	DISTANCE OF WATER SAMPL EFROM DUMPSITE
OSUBI	ODL	Osubi Dumpsite Leachate	05˚ 34' 38.5" N 005˚ 48' 07.5" E 11m	Above 10years	
	OBW 1	Osubi Dumpsite Bore-hole 1	05˚ 34' 39.7" N 005˚ 48' 09.3" E 13m		15m
	OBW 2	Osubi Dumpsite Bore-hole 2	05˚ 34' 52.4" N 005˚ 48' 18.8" E 15m		120m
NIGER-CAT	NDL	Niger-CAT Dumpsite Leachate	05˚ 34' 30.2" N 005˚ 44' 56.5" E 11m	Above 10years	
	NBW 1	Niger-CAT Dumpsite Bore-hole 1	05˚ 34' 26.7" N 005˚ 44' 51.7" E 7m		13m
	NBW 2	Niger-CAT Dumpsite Bore-hole 2	05˚ 34' 32.6" N 005˚ 44' 45.7" E 12m		110m
MOFOR	MDL	Mofor Dumpsite Leachat	05˚ 32' 05.1" N 005˚ 49' 42.2" E 14m	5years	
	MBW 1	Mofor Dumpsite Bore-hole 1	05˚ 32' 07.5" N 005˚ 49' 42.7" E 12m		17m

	MBW 2	Mofor Dumpsite Bore-hole 2	05˚ 32' 07.3" N 005˚ 49' 36.7" E 11m		102m

FIELD PROCEDURE

Leachate samples were collected and analysed to assess their characteristics and stability. Groundwater samples were collected from two monitoring wells, one at each site, which aredrilled around the landfills sites in order to monitor the closer aquifer extent of contamination while the other at about 100m away from the site to serve as a control. From each site, one leachate sample and two bore-hole water samples were collected making it a total of three leachate sample and six bore-hole water samples. All the sampled wells are privately-owned, self-supply options that are used extensively for domestic and other purposes. The samples were extracted with the aid of cut plastic containers which served as a funnel placed at the mouth of the well labelled plastic containers. Samples were collected in the labelled, pre-cleaned and sterilised plastic container of 1.0L capacity. Because the SWD sites are not equipped with leachate collectors, the samples were collected at the leachate ponds formed around the sites.

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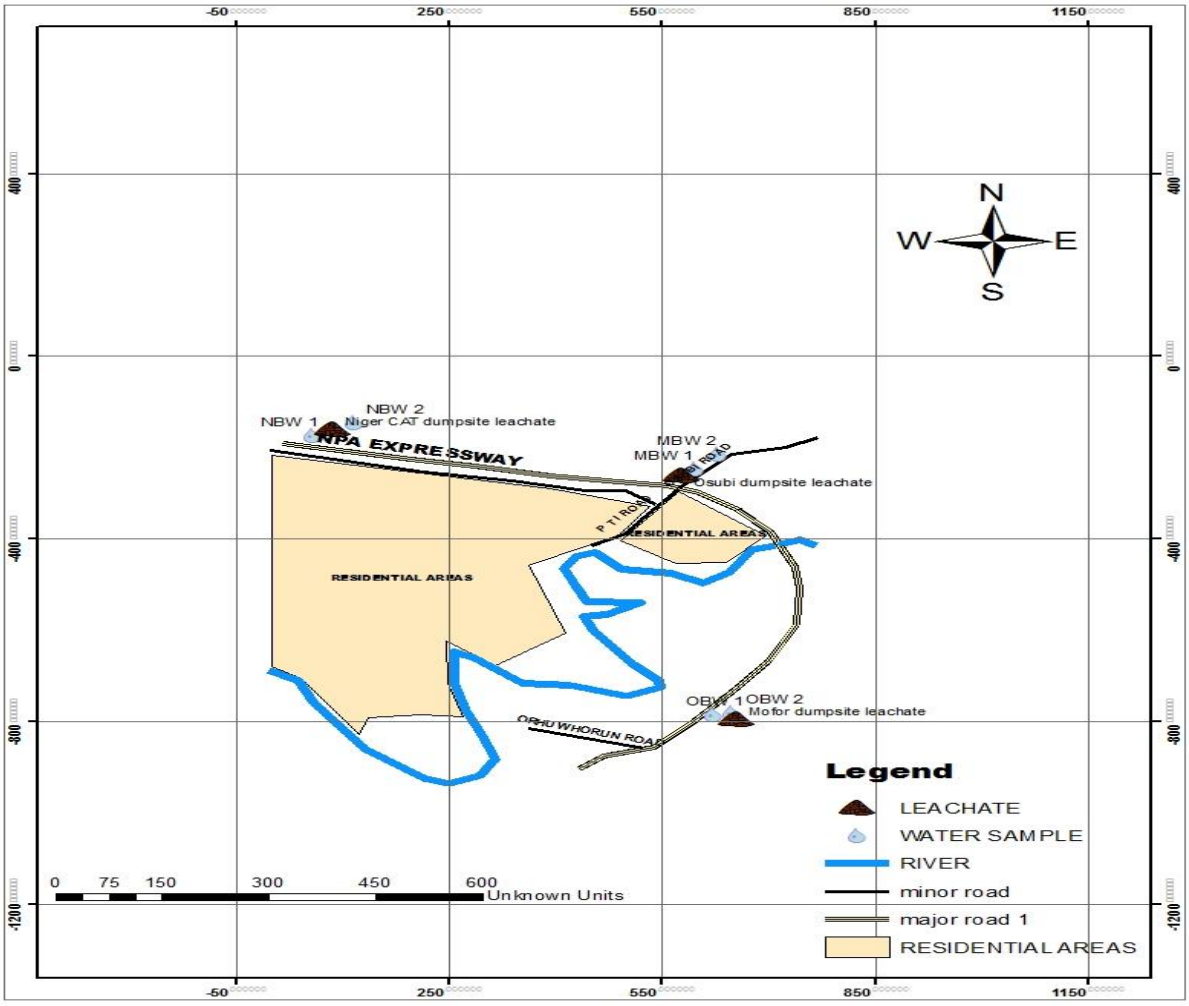

Figure 1: MAP OF STUDY AREA SHOWING SAMPLING LOCATIONS

All the samples were collected, preserved, unambiguous labels were used to identify all sample containers prior to being properly stored. The samples were then stored in cooler boxes at temperatures below 5°C, and transported immediately to the laboratory. They were then stored in a refrigerator at 4°C prior to the analyses.

The samples were analysed according to the Standard Methods for the Examination of Water and Wastewater at the Tudaka Laboratory. In landfills, leachate pollutantmeasurements included organic contaminants [measured as Biochemical Oxygen Demand (BOD_5) or Chemical Oxygen

Demand (COD) by Dilution method, Dissolved Oxygen (DO) was determined using iodometric with starch end point (winkler reagent)], Sulphate(SO_4^{3-}), Nitrates(NO_3^-), Chloride(Cl^-), Phosphate(PO_4^{2-}), Calcium (Ca), Magnesium (Mg), Total Dissolved Solids (TDS), pH, Temperature, Electrical Conductivity and Turbidity. Three heavy metals [Lead (Pb), Iron (Fe)and Cadmium (Cd)] were chosen because of their availability in landfill leachates. Heavy metals were determined using Atomic Absorption Spectrophotometer (ASS) APHA 301 flame system. Microbial analysis such as Total Coliform Count was determined using Multiple Tube Test (APHA 9222A).

(IV) PRESENTATION OF RESULTS

The results of the physiochemical parameters measured in the study area are summarized in the table below. The parameters that were measured include; pH, Temperature (˚C), Total Dissolved Solids (TDS) in mg/l, Electrical Conductivity (µs/cm), Dissolved Oxygen (DO) in mg/l, Biochemical Oxygen Demand (BOD) in mg/l, Chemical Oxygen Demand (COD) in mg/l, Phosphate (PO_4^{2-}) in mg/l, Sulphate (SO_4^{3-}) in mg/l, Nitrate (NO_3^-) in mg/l, Turbidity (N.T.U), Chloride (Cl^-) in mg/l, Calcium (Ca) in mg/l, Magnesium (Mg) in mg/l, Lead (Pb) in mg/l, Cadmium (Cd) in mg/l and Iron (Fe) in mg/l. It is also imperative to state that microbiological analysis such as total coliform count was carried out. The essence of these data measurement is to determine the quality of the water in the study area.

Table 2: Summary of physiochemical parameters of surface water samples of Effurun and its environs compared with SON (2007) and WHO (2006) standards for drinking water.

Parameters	ODL	NDL	MDL	OBW 1	OBW 2	NBW 1	NBW 2	MBW 1	MBW 2	SON (2007)	WHO (2006)
Ph	6.72	6.58	6.51	4.35	4.72	3.94	5.29	5.57	4.85	6.5-8.5	6.5-8.5

Temp (˚C)	28.5	27.3	28.4	29.7	27.6	28.1	27.0	29.1	29.8	Ambient	>40
TDS (mg/l)	1,380	1,810	2,540	60	37	277	33	32	20	500	500
Conductivity(µs/cm)	2,484	3,258	4,572	108	66	498	59	57	36	1000	500
DO (mg/l)	ND	ND	ND	4.30	4.10	4.90	4.70	4.00	3.90	-	8.0
BOD_5 (mg/l)	48.50	36.73	62.14	1.80	1.40	2.70	2.10	2.00	1.20	0	0
COD (mg/l)	121.25	94.33	155.40	4.47	3.38	6.69	5.21	5.03	3.00	-	-
Phosphate(mg/l)	36.81	60.52	96.32	2.16	0.94	3.42	0.68	0.54	0.33	-	10
Sulphate (mg/l)	102.67	119.40	132.97	5.82	1.58	12.77	1.24	1.07	0.85	100	400
Nitrate (mg/l)	20.90	29.11	47.76	1.93	0.49	4.84	0.35	0.31	0.18	50	50
Turbidiy(N.T.U.)	241.10	184.21	980.40	0.69	1.13	0.54	0.56	1.20	1.90	5	5
Chloride (mg/l)	226.24	297.54	416.42	19.65	12.46	88.93	9.72	8.54	7.37	250	200
Calcium (mg/l)	20.87	53.76	85.44	2.53	0.61	8.26	0.45	0.21	0.15	50	75
Magnesium(mg/l)	7.25	22.53	41.69	1.04	0.32	3.11	0.18	0.13	0.07	0.20	20
Lead (mg/l)	0.56	0.72	0.97	0.11	0.08	0.20	0.31	0.08	0.05	0.01	0.01
Cadmium (mg/l)	0.24	0.36	0.52	0.06	0.04	0.09	0.03	0.02	0.01	0.003	0.003
Iron (mg/l)	3.63	4.99	8.21	0.97	0.72	1.98	0.62	0.59	0.37	0.3	0.3
Coliform count (MPN/100ml)	>16,000	>16,000	>16,000	5,000	3,500	2,800	2,200	16,000	9,000	10cfu/ml	0

NB: ND means No Detection

ODL	Osubi Dumpsite Leachate
NDL	Niger-cat Dumpsite Leachate
MDL	Mofor Dumpsite Leachate
OBW 1	Osubi Dumpsite Bore-hole 1
OBW 2	Osubi Dumpsite Bore-hole 2
NBW 1	Niger-cat Dumpsite Bore-hole 1
NBW 2	Niger-cat Dumpsite Bore-hole 2
MBW 1	Mofor Dumpsite Bore-hole 1
MBW 2	Mofor Dumpsite Bore-hole 2

(V) DISCUSSION AND INTERPRETATION

HYDROGEN POTENTIAL (pH)

The pH of water is a measure of how acidic or basic the water is according to the pH scale ranging from 0 – 14 with 7 being neutral, when the pH value is less than 7 it is acidic, when greater than 7 it is basic/alkaline. The pH value of the borehole water samples collected from the three study areas (Osubi, Niger-cat and Mofor) falls between the ranges of 3.94 - 5.57 with a mean value of 4.8 which falls below the S.O.N. and W.H.O.(6.5 – 8.5) standard. This suggest that the water samples are said to acidic and indicates the presence of metals in the samples particularly toxic metals. This falls outside the WHO and SON permissible range of 6.5-8.5 and confirmed the acidic natureof the water from the wells. Metals such as zinc, damaged battery cells (lead, mercury and alkaline) and improperlydisposed used cans of aerosol and other disinfectants deposited in the landfill as waste, after exposure to air andwater and may have found their ways to the well-water levels through seepage to give the toxic, acidic nature it

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currently has, as such the water is not suitable for human consumption; the acidity of the water samples is a direct function of the leachate that must have percolated into the ground water.

TEMPERATURE (^{0}C)

The temperature of the water samples range between 27.0 – 29.8^{0}C with an average mean of 28.4^{0}C, which is not up to the S.O.N. and W.H.O. standard for drinking water. Although this high value of temperature has no undesirable effect on both human beings and animals.

TOTAL DESSOLVED SOLIDS (TDS)

The total dissolved solids include silica,cations and anions dissolved in water. The TDS values for the water samples gotten from the study areas ranges from 20 – 277 mg/l with an average mean value of 76.5mg/l which falls below the S.O.N. and W.H.O. standard limit of 500mg/l of drinking water which classifies the water as fresh water and acceptable for consumption.

ELECTRICAL CONDUCTIVITY (EC)

Electrical conductivity of water is related to the concentration of ions capable of carrying electric current. Electrical conductivity is an estimation of the total dissolved solids in water. The electric conductivity from the various water samples ranges from 36 – 498µs/cm with an average mean value of 137.33 µs/cm which falls below established standard indicating the presence of more non-conductive contaminants.

DESSOLVED OXYGEN (DO)

Dissolve oxygen in water is a measure of the amount of gaseous oxygen dissolved in an aqueous solution; these oxygen gets into water by diffusion from the surrounding air, by aeration and as a waste product of photosynthesis. The dissolved oxygen in the water sample varies from 3.9 – 4.9 mg/l with a mean value of 4.4mg/l which is below the range of DO standard established by W.H.O, this infer the presence of pollutants that use up the oxygen in water. Heavy usage of the DO by the pollutants were noticed and showed that the wells were unsafe forconsumption.

BIOLOGICAL OXYGEN DEMAND (BOD)

Biochemical oxygen demand is the amount of oxygen expressed in mg/l or parts per million(ppm) that bacteria take from the water when they oxidize organic matter. The BOD

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range from the result of water sample analysis is from 1.2 –2.7mg/l with a mean value of 1.95mg/l which is above the AWRI established standard limit of 1.5mg/l for excellent water with respect to BOD value, this suggests that the water is not good and has been polluted by excess organic matter as a result of the effect of the leachate in the groundwater.

PHOSPHATE (PO_4^{3-})

Phosphate concentration level in the study area is between the ranges of 0.33 – 3.42mg/l with an average of 1.88mg/l, although S.O.N. (2007) did not recognize any value for Phosphate, W.H.O. (2006) however recognizes the standard value of 10mg/l. The samples falls below the standard and as such is safe for drinking and other uses therefore posing no threat to the health of humans.

SULPHATE (SO_4^{3-})

The concentration level of sulphate in the water samples ranges from 0.85 – 12.77mg/l with an average of 6.81mg/l which falls below the established standards, therefore this indicates that the water is safe for drinking in terms of the sulphate concentration.

NITRATE (NO_3^-)

The concentration of nitrate range from 0.31 – 4.84mg/l with an average of 2.58mg/l and this value falls within the W.H.O. (2006) and S.O.N. (2007) stipulated permissible limit of 50mg/l and as such pose no health threat.

TURBIDITY

Turbidity in water is a function of the suspension of fine colloidal particles that do not readily settle out of solution and can result in cloudiness. Turbidity causes light to be scattered and absorbed instead of being transmitted in straight line through the sample. Turbidity is expressed in Nephelometric Turbidity Unit (NTU) and is determined by an instrument known as Nepholometer. From the water sample analyzed, the result show turbidity value ranges from 0.54 - 1.9 NTU with an average mean value of 1.22NTU which falls below the W.H.O. and S.O.N. standard limit of 5NTU. Low or excess turbidity in water has no undesirable effect on both human beings and animal except for aesthetic reasons whereby it may shield some micro-organisms from disinfection.

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CHLORIDE (Cl^-)

The chloride concentration has a range of 7.37 – 88.93mg/l. Generally a concentration of Cl below 20mg/l is regarded as low. Thus there is low chloride concentration in the study area and no indication of salt water encroachment into aquifers (except for the well at Niger-CAT Dumpsite borehole1 which have a maximum concentration of 88.93 mg/l). A 40mg/l and above in the water is an indicative of salt water encroachment.Though below the WHO and SON levels, its presence connotes pollution hence require treatment before use. The high value of chlorides connotes the presence of weathered silicate rich rocksbeneath the overburden and leaching from soil due toinfiltration from the landfill and other anthropogenic activities. W.H.O. (2006) standard and S.O.N. (2007) for drinking water stipulates 250mg/l as the tolerant value for this parameter. In the light of this, water from the study area would be free from chloride related problem. The Sources of chloride in groundwater is rainwater, which is the major source of recharge for the wells.

CALCIUM

The concentration of Calcium ranges from 0.15 – 8.26mg/l with a mean concentration of 4.2mg/l, this value fall below the stipulated standard for permissible limit thus the water is harmless and safe with regards to this parameter. Calcium levels though low still portend danger of hardnessin water. The implication is that forming lathe with soap willbe a major challenge for domestic users.

MAGNESIUM

The concentration of Magnesium ranges from 0.07-3.11mg/l, with a mean value of 1.59mg/l. The concentration level are below the W.H.O. (2006) standard of 20mg/l and above S.O.N. (2007) of 0.20mg/l set aside drinking water. This all depends on consumer acceptability (S.O.N. 2007).

LEAD (Pb)

The concentration of Lead in the water sample ranges from 0.05 – 0.31mg/l with a mean value of 0.14mg/l. the concentration level are much higher than the stipulated permissible limit of the S.O.N. and W.H.O. (0.01mg/l) standard set aside for drinking water, as such this poses a great

danger on the people consuming the water because constant intake of this water could lead to cancer, interference with vitamin D metabolism, it could also affect mental development in infants, toxic to central and peripheral nervous system (S.O.N. 2007). The presence of Lead in the water is as a result of leachate contamination from the decomposition of Lead battery, electronic waste, some used aerosol cans and other materials with certain degree of toxicity

CADMIUM (Cd)

Cadmium concentration in the water ranges from 0.01 – 0.09mg/l with a mean value of 0.04mg/l. The water samples MBW 1,MBW 2 and NBW 2 falls within the permissible limit of the stipulated standards, therefore are considered safe for drinking and not harmful to human health but the waatr samples OBW 1, OBW 2 and NBW 1(especially), are higher than the permissible limit of 0.03mg/l of the S.O.N (2007) and W.H.O. (2006) standards. A constant intake of this water is very harmful to human health as it could be toxic to the kidney. (S.O.N. 2007).

IRON

Iron concentration in the study areas ranges from 0.37 – 1.98mg/l with a mean value of 1.17mg/l. The WHO (2006) and S.O.N (2007) standards for this parameter is 0.3mg/l therefore, the concentration of Iron is higher than the permissible limit of the stipulated standards but has no significant health impact. The introduction of the Iron into the water could be as a result the leachate contamination based on the iron materials dumped at the site. The mobility and subsequent downward infiltration of these minerals through the porous and permeable formation account for the presence of iron in the water from the study areas. Iron has no adverse health impact but excess concentration in the human system through consumption of this water which is above WHO (2006) and SON (2007) permissible limit of 0.3mg/l report gives an objectionable and sour taste in mouth. It was also remarked that the formation of goitre in adults was the resultof consumption of water with quantity of iron above thespecified values

TOTAL COLIFORM COUNT (TCC)

The concentration of coliform in the water sample ranges from 2200 – 16000 MPN/100ml with a mean value of 6416.7 MPN/100ml. This value is much greater than the permissible limit of the stipulated standard which suggest that the study areas has been highly polluted by bacteria which

is as a result of faecal contamination of human waste from landfill in the study area.Total coliforms are a group of bacteria commonly found in the environment, for example in soil or vegetation, aswell as the intestines of mammals, including humans. Total coliform bacteria are not likely to cause illness, but their presence indicates that your water supply may be vulnerable to contamination by more harmful microorganisms. Escherichia coli (E.coli) is the only member of the total coliform group of bacteria that is found only in the intestines of mammals, including humans. The presence of E.coli in water indicates recent faecal contamination and may indicate the possible presence of disease-causing pathogens, such as bacteria, viruses, and parasites. Although most strains of E.coli bacteria are harmless, certain strains, such as E.coli 0157:H7, may cause illness.

GRAPHICAL REPRESENTATION OF ANALYSIS

The histogram presents the abundance of these ions in the water samples following the order: Ca > Mg> Fe= Cl > SO4 > NO3> PO4. Chloride is the dominant anion found in the groundwater of the study area because the sources of chloride in groundwater is rainwater, which is the major source of recharge for the wells.

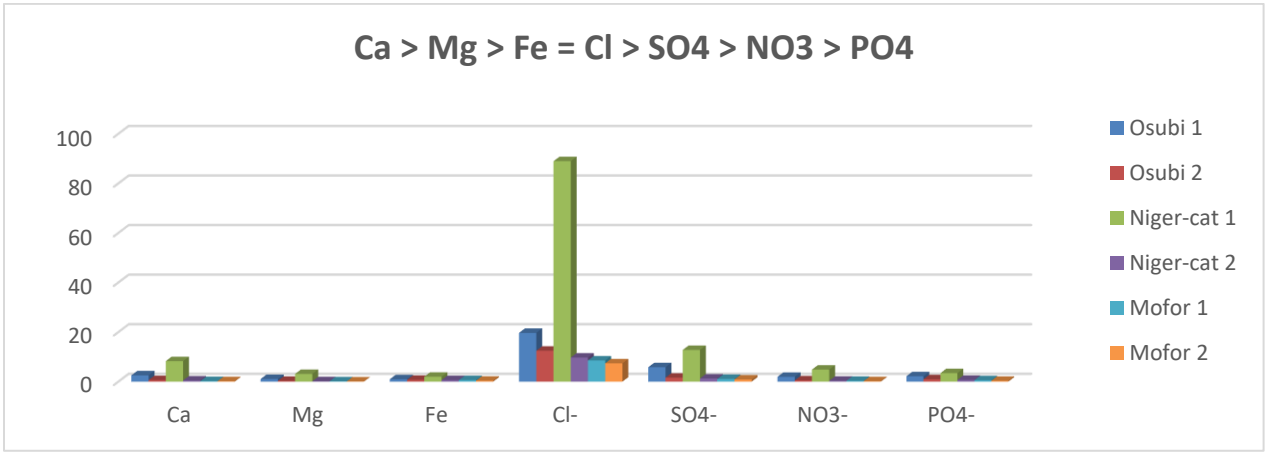

Figure 2: IONIZATION ORDER OF THE CATION AND ANION

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CATION CONCNTRATION

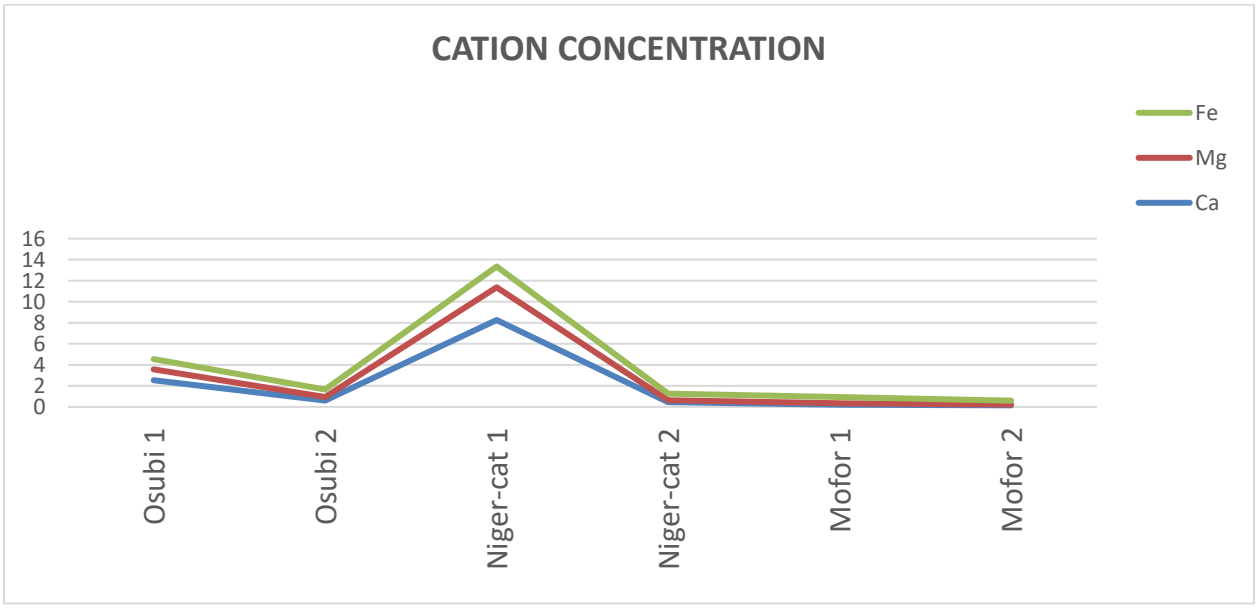

Figure 4 CATION CONCENTRATION IN THE WATER SAMPLE (Niger-cat 1)

ANION CONCENTRATION

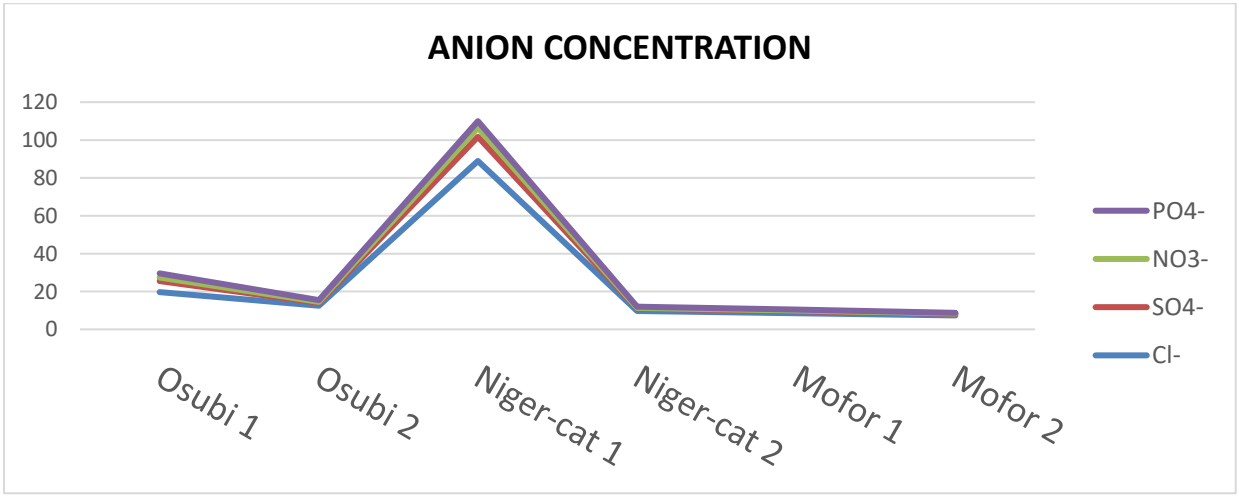

Figure 5: ANION CONCENTRATION IN THE WATER SAMPLE (Niger-cat 1)

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HEAVY METALS CONCENTRATION

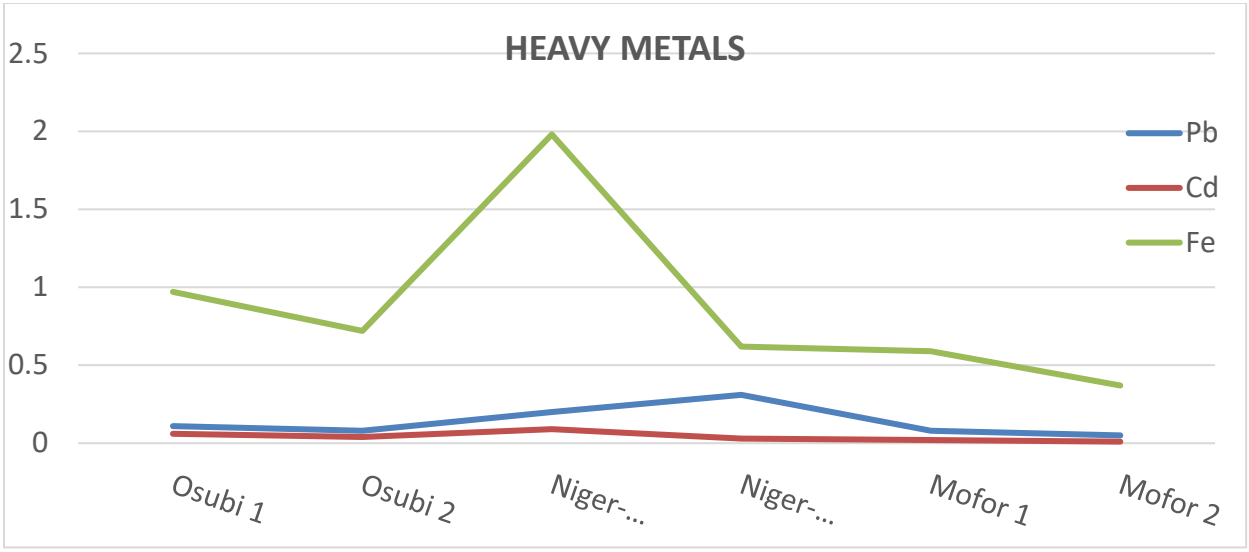

Figure 6: HEAVY METALS CONCENTRATION IN THE WATER SAMPLES (Niger-cat)

COMPARING THE CONCENTRATION OF LEACHATE AND WATER SAMPLE PARAMETERS

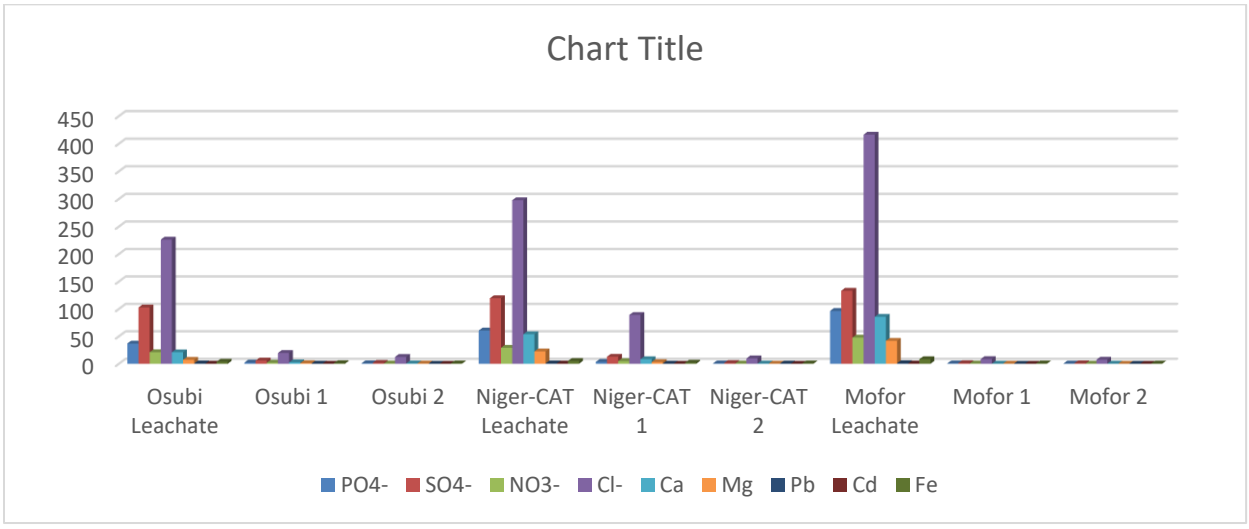

Figure 7 : LEACHATE SAMPLES AND WATER SAMPLES COLLECTED AT THE DIFFERENT LOCATIONS COMPARED

ANIONS AND CATIONS WITH WHO (2006) AND SON (2007) STANDARDS

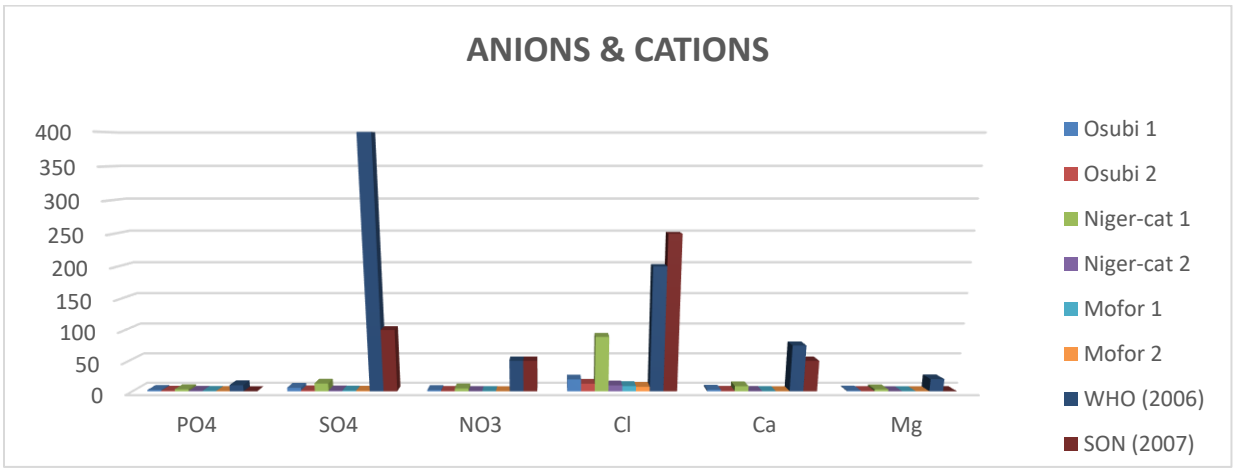

Figure 8: CATIONS AND ANIONS COMPARED TO SON (2007) AND WHO (2006) STANDARDS

HEAVY METALS WITH WHO (2006) AND SON (2007) STANDARDS

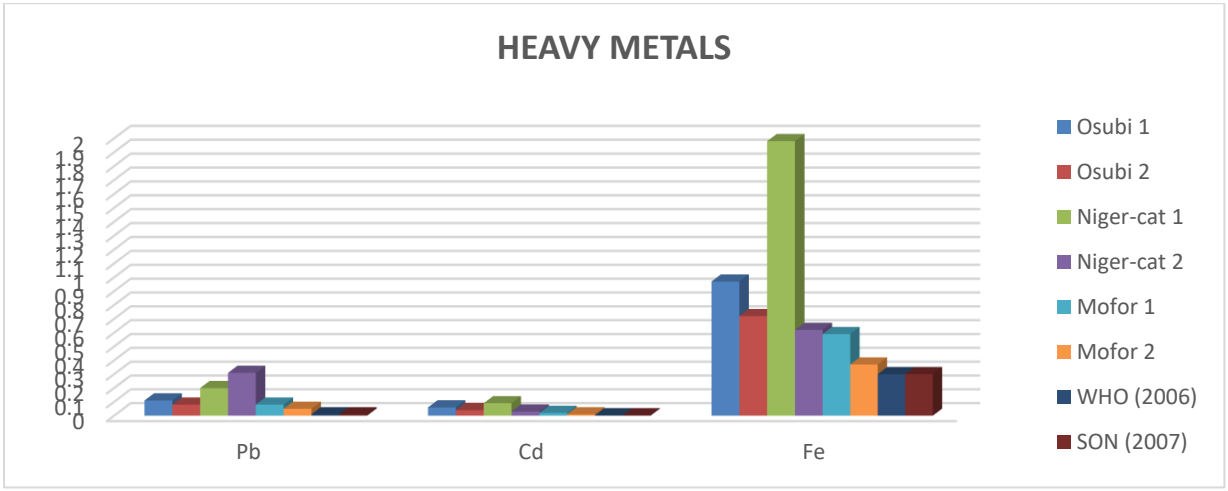

Figure 9: HEAVY METALS COMPARED TO SON (2007) AND WHO (2006) STANDARDS

STATISTICAL DISTRIBUTION DIAGRAMS

Schoeller and Durov statistical distribution diagrams among others are used in this work to gain better insight into the hydrochemical processes operating in the groundwater system.

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SCHOLLER DIAGRAM

A Schoeller Diagram is a semi-logarithmic diagram of the concentrations of the main ionic constituents in water (SO4, HCO3, Cl, Mg, Ca, Na/K) in equivalents per million per kg of solution (mEq/kg). The diagram gives absolute concentration, but the line also gives the ratio between two ions in the same sample. The Schoeller semi- logarithmic plots of the data further confirmed this water type. The peaks indicate the dominant ions in the water samples while the trough indicates the less dominant ions. In this study, the dominant ions are Ca^{2+}, Mg, Fe and Cl^{-} ions.

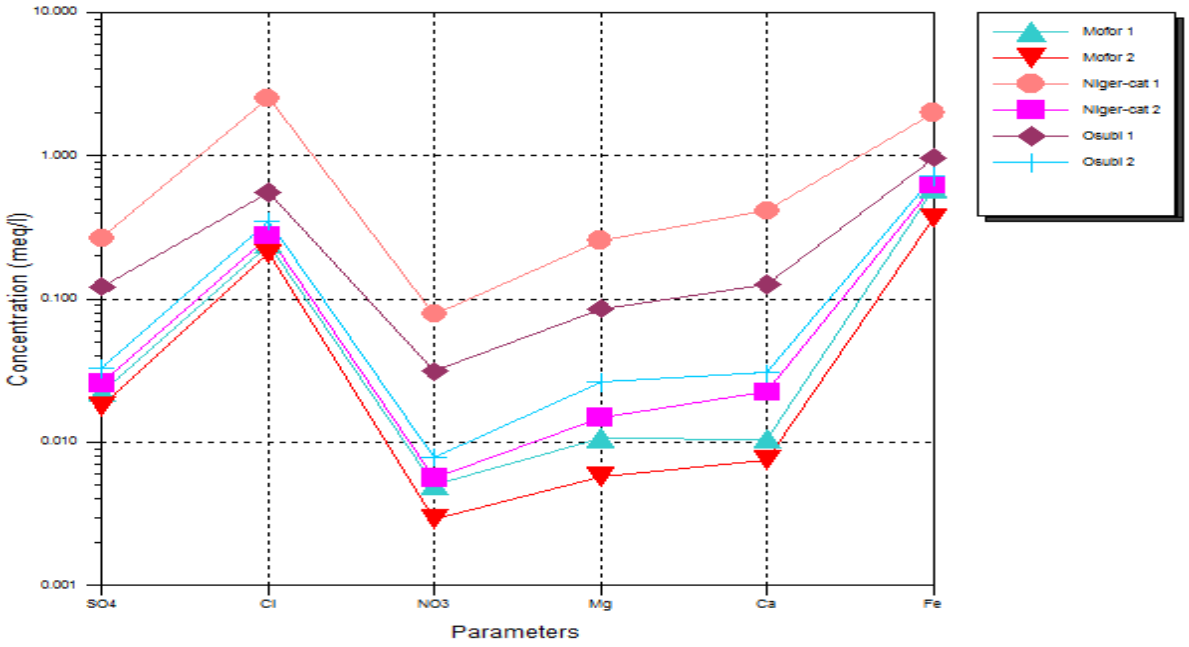

Figure 10: THE DOMINANT IONS IN THE WATER SAMPLES (Ca, Mg, Fe and Cl).

DUROV DIAGRAM

The Durov plot is used to graphically illustrate cation/anion concentrations, relative to TDS and pH. It primarily plots Cations (i.e. Na + K, Ca and Mg) and Anions (i.e. Cl, HCO3 and SO4), and total cations vs. total anions only. The expanded plots, had TDS and pH added.

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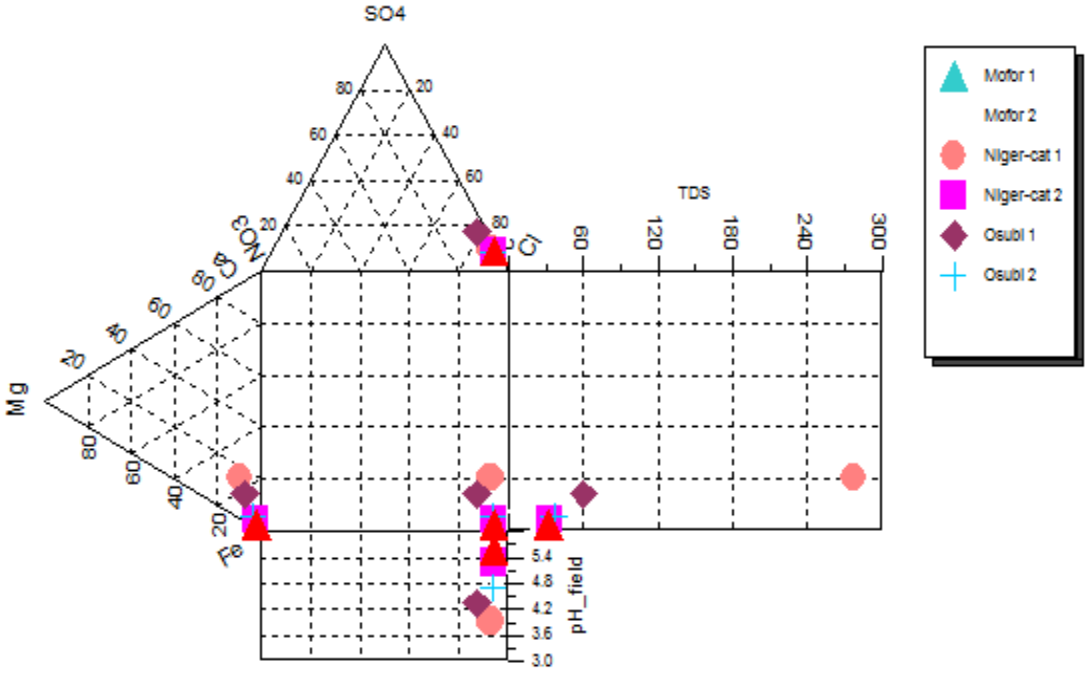

Figure 11: CATION/ANION CONCENTRATIONS RELATIVE TO TDS AND pH

CONCLUSION

Although leachate was characterized by high contents of organic and inorganic chemicals as well as the toxic nature arising from heavy metals concentrations, the groundwater through monitoring wells around the active cells did not has severe contamination, whereas certain parameters exceeded the WHO (2006) and SON (2007) standards. These parameters include pH, BOD_5, Pb, Cd, Fe and TCC .However, the results indicated poor sanitation and damaging effects to health of both man and animals if surrounding well waters were used for domestic purposes. As a result of the high levels of chemical and bacteriological contamination of water from the boreholes, health problems as typhoid fever, worm infestation are imminent when such water is consumed in its present state. Presence of total coliform bacteria indicates microbial pollution of the groundwater by anthropogenic activities. The leaching of both Ca and Mg into the groundwater table causes the water to be hard. Presence of Fe, Pb and Cd in detectable quantities

was an indication of toxicity level in the groundwater and therefore poses serious environmental and health risk to humans ,animals and even the soil around the study area.

REFERENCES

APHA. (1998), "Standard methods for examination of water and wastewater", 19th edition American Public Health Association, Water Environment Federation Publication, Washington, DC.

Akpokodje, E.G., Etu-Efeotor, J.O.,& Mbeledogu,I.U (1996)"A study of environmental effects of deep subsurface injection of drilling waste on water resources of the Niger Delta" CORDEC, University of Port Harcourt, Choba, Port Harcourt, Nigeria.

Aristedemou, E. Thomas-Betts, A. (2000): DC Resistivity and Induced Polarization Investigation at a Waste Disposal Site and its Environments. *J Applied Geophysics*, 44, p. 275-302

Brown, K. and Donnelly, K. (2005). Rachael's Harzardous Waste News No. 90

Butow, E., Holzbecher, E. and Kob, E.: (1989), Approach to Model the Transport of Leachates from a Landfill Site including Geochemical Processes, Contaminant Transport in Groundwater. *Kobus and Kinzelbach, Balkema, Rotterdam*, pp. 183–190.

Dahlin, T. Leroux, V. and Nissan, J. (2002): Measuring Techniques in Induced Polarization *Imaging, Journal of Applied Geophysics.* Vol. 50, p. 279-298.

Maron, P. (1969). Stratigraphical aspects of the Niger delta, Nig. J. Min. Geol. 4:3-12.

Obaje, N. G. (2009). Geology and Mineral Resources of Nigeria. Nasarawa state University Dept. of Geology and Mining Keffi Nigeria. p. 50

Offodile ME (1976). A review of the geology of the Benue Valley, In: (CA Kogbe, Ed.) Geology of Nigeria, Elizabethan Publishing Co. Lagos, 319-330.

Peter, B. Woodbury. (2005). Municipal Solid Waste Composting: Potential Effects of Heavy Metals in Municipal Solid Waste Composts on Plants and the Environments. *Boyce Thompson Institute*

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for Plant Research at Cornell University. [Online] Fact Sheet 4 of 7 from http://compost.css.cornell.edu/MSWFactSheets/mws.fs4.html [Accessed 23/08/2015]