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# Leachate Effect On Underground Water And Potential Health Impact Of Some Owerri Municipalities Dumpsites In Imo State

Chinedu Nwoke

Chinedu Nwuke (Ph.D)

***Abstract:** Physiochemical and bacteriological analyses of water samples from three different boreholes located close to a dumpsite at Owerri, Nigeria were carried out to evaluate the level of dumpsite pollution on underground water. Some soil hydraulic properties were also analyzed to determine the penetration rate of leachate into the underground water. Borehole locations were at about distances of 50m, 100m, and 500m respectively away from the dumpsite. The parameters determined included; turbidity, temperature, pH, chemical oxygen demand (COD), total dissolved solids (TDS), Total Hardness (TH), Total Iron, Nitrate, Nitrite, Chloride, Calcium and some metals such as Copper, Zinc and Lead using standard laboratory equipment and procedures. Most of these parameters indicated slight pollution but were however below the Nigerian Standard for Drinking water quality (NSDWQ) and World Health Organization (WHO) limits permissible for consumption. The pH ranged from 5.50 to 6.95 indicating toxic pollution, turbidity values were between 1.0 and 3.5 NTU and temperature ranged from 26.0$^0$C to 27.8$^0$C. The concentrations of COD, TDS, and TH ranged from 0.8-2.2mg/L, 200-352mg/L and 130-150mg/L respectively. The concentrations of calcium, nitrate, nitrite and chloride ranged from 68-75mg/L, 46-56mg/L, 0.7-1.1 mg/L and 160-193mg/L respectively. For metals like iron, lead, zinc they ranged from 0.9-1.4mg/L,0.1 mg/L- undetected and 0.1mg/L - undetected respectively, while copper was only detected in one site with values of 0.1 and 0.2mg/L respectively. Bacteriological analysis ranged from 0-50/100ml MPN for all the boreholes. For the soil hydraulic properties like; soil infiltration rate (I.R) it ranged from 5.0-5.6 cm/hr., soil bulk density ranged from 1.0-1.2 g/cm$^3$, cation exchange capacity (C.E.C.) and effective porosity (E.P) ranged from 1.0-1.1% and 40-65% respectively. Statistical analyses indicated significant differences in all the parameters tested for, in the samples at ($p<0.05$). The results showed that all the underground water were slightly polluted but still require certain levels of treatment before use. Therefore, the use of advanced water treatment technology and water purification methods such as sedimentation, filtration, distillation and chlorination of drinking water before consumption to prevent infections are recommended also adequate public enlightenment on proper waste disposal management, treatment and siting of boreholes far away from dump sites are encouraged.*

## I. INTRODUCTION

A leachate is any liquid that, in the course of passing through matter, extracts soluble or suspended solids, or any other component of the material through which it has passed. Groundwater pollution is mainly due to anthropogenic activities and the presence of contaminants, organic and inorganic compounds which has infiltrating through the top soil to deep depth beneath the earth surface. The rate of percolation is relative to various soil parameters such as soil infiltration rate, soil porosity, cation exchange capacity, the solubility of the pollutants and the direction of underground water flow. In recent times, the impact of leachate on underground water quality and other water resources has raised concern because of high volume of waste generated as a result of industrialization and urbanization because Once in contact with decomposing solid waste, the percolating water becomes contaminated, and if it then flows out of the waste material it is termed leachate, additional leachate volume is produced during the decomposition of carbonaceous materials including methane, carbon iv oxide and complex mixture of acids, aldehydes alcohols and simple sugars (Akinbile 2011).

When water percolates through waste and other particle, it induces, promotes and assists the process of biodegradation by

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bacteria and fungi. These processes in turn releases intermediates like ethanol, acetate, lactate, methane etc. This may rapidly lead to biotransformation of any available oxygen, creating an anoxic environment. In actively decomposing dumpsites or landfills the release of pollutants from sediments (under certain conditions) poses a high risk to groundwater resources if not adequately managed (Yusoff, 2011). Protection of groundwater is a major environmental issue since the importance of water quality on human health has attracted a great deal of interest lately. Assessing groundwater quality and developing strategies to protect aquifers from contamination are necessary for planning and designing water resources. Open dumps are the oldest and most common way of disposing wastes, although in recent years, thousands have been closed, many are still being used .Waste management has become increasingly complex due to the increase in human population, industrial and technological revolutions and the processes that control the fate of wastes in the soil. Issues such as nutrients release rate and high activities of anaerobes, leaching of nutrients and metals through macro pores as suspended solids and sludge organic matter on degradation are often of great threat. Toxic chemicals that have high concentration of nitrate and phosphate derived from waste in the soil can filter through a dump and contaminate both underground and surface water (Akinbile and Yusoff 2011). Bacteria, pathogens, insects, rodents, snakes and scavenger birds, dust, noise, are some of the opportunistic inhabitants of most of the open dumpsites.

AIM OF THE STUDY

The aim of the study is to evaluate the effect of dumpsites pollution on underground water quality in Owerri municipalities, in Imo state of Nigeria and its possible health impact.

## II. DEMOGRAPHY AND STUDY AREA

DEMOGRAPHY

Owerri has a population of approximately 150,000 people according to 2006 population census with area of 134km$^2$.It is located between latitude 4$^o$45N and 5$^o$50N and longitude 6$^o$32E and 7$^o$30E. It experiences heavy rainfall with annual rainfall of about 2000-2400mm/yr. with superficial rainfall distribution being bimodal with peaks in July and September and a little break in august. The climate is humid semi-hot equatorial type with relative humidity that oscillates between 75% and 90% in rainy and dry season and average temperature of 20$^o$C. There is rapid urbanization witnessed by continuous expansion of the city and development of sites also the high influx of tourists as there are lots of tourist sites especially in the hospitality industry leading to the generation of large volume of waste materials which eventually find their way in the dumpsites.

STUDY AREA

- ✓ Dump site of Imo state environmental transformation company (ENTRACO) along Port Harcourt road (site 1)
- ✓ Mechanic village dump site along Aba road Owerri (site 2)
- ✓ Orji market dump site along Okigwe road Owerri (site 3)

## III. MATERIAL AND METHODS

DETERMINATION OF DIRECTION OF FLOW OF UNDERGROUND WATER

The services of a geologist was used to determine the direction of flow of the underground water in the three dump sites using GEOSEEKER which measures a depth of between 5metres (16 feet) to 250meters(820 feet) by using electrical current to measure potential difference to read soil sensitivity. Based on the ground resistance the detector, water-bearing ground then transmits its scan data in 3d graphics. In static water level from which the major and minor flow directions were measured, the result shows that ground water flows predominantly towards the south western parts of the city with the main forces affecting groundwater movement being gravity and external pressure due to pumping .The flow pattern suggests that the southern part of study area which is site 1(lat 5$^o$28N long 7$^o$13E) and site 2(lat 5$^o$25N long 7$^o$15E)are more susceptible to groundwater contamination as a result of hydraulic head as the water flows there while site 3(lat 5$^0$20N long 7$^0$19E) is within the northern part of the state is less susceptible to filtration.

SAMPLE COLLECTION

*LEACHATE COLLECTION*

Leachate was collected from the three sites under investigation using plastic container covered with a sieve mesh placed beneath the pith which dripped into the container due to gravity.

*WATER SAMPLE COLLECTION*

4 liter container was used each to collect water samples at approximately 50m, 100m and 500m away from the three dumpsites then stored in a 600ml polyethylene bottle.

*SOIL SAMPLE COLLECTION*

Soil samples were collected at all the three sites using plastic containers.

## IV. WATER ANALYSIS

The following were analyzed

- ✓ *Physical parameters* including; odour, taste, colour, turbidity (using Turbid meter at 90$^o$ scattering) and temperature (using thermometer)

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- ✓ *Chemical parameters* including; PH (using PH meter) Chemical oxygen demand (titration using potassium dichromate in the presence of sulphuric acid, silver and mercury sulphate to produce $CO_2$ and $H_2O$) total dissolved solids (using gravimetric method), total hardness(titration using sodium EDTA with eriochrome black Indicator), Calcium (titration using EDTA),chloride(titration using silver nitrate with chromate indicator) using flame atomic spectrophotometer includes; total iron, nitrate, nitrite, copper, zinc, lead.

BACTERIOLOGICAL ANALYSIS

(By multiple test tube technique using OXOID macConkey broth) MacConkey agar is used in the isolation of gram negative enteric bacteria and the differentiation of lactose fermenting from lactose non fermenting gram negative rod bacteria particularly the enterobacteriaceae family.

SOIL ANALYSIS (HYDRAULIC PROPERTIES)

Infiltration rate (using double ring infiltrometer),effective porosity (using direct method of determining bulk volume of porous sample and volume of sample without pores), soil bulk density (using core method), cat ion exchange capacity (using ammonium acetate technique), fraction of organic carbon in soil (using wet oxidation method).

## V. TEST RESULTS AND DISCUSSIONS

*KEY;*

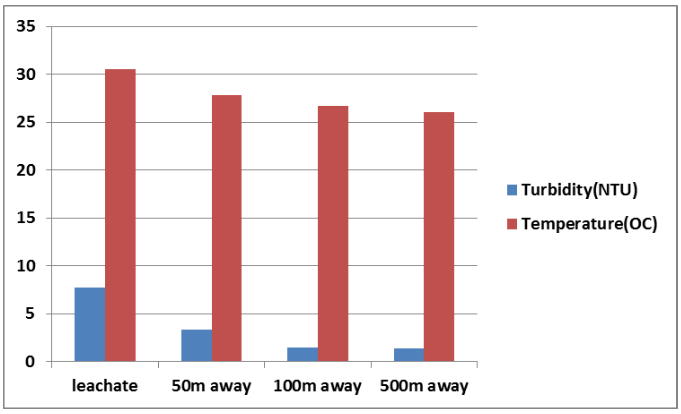
PH has no dimension while all units are in mg/L
I.R means Infiltration rate
ND means not detected
E.P. means Effective porosity
COD means chemical oxygen demand
B.D. means Bulk density
TDH means total dissolved solid
C.E.C. means Cat ion exchange capacity
TH means Total hardness
Cmol/kg means moles of electric charge per kilogram
WHO means World health organization
O.C. means Soil organic carbon
NSQDW means National standard quality for drinking water



TEST RESULTS

| Sample | Taste | Colour | Smell | Turbidity (NTU) | Temperature ($^oC$) |
|---|---|---|---|---|---|
| leachate | Not tasted | Not Clear | Pungent smell | 7.7 ±0.3 | 30.5±0.8 |
| 50m away | Tasteless | Clear | No smell | 3.3±0.5 | 27.8±0.7 |
| 100m away | Tasteless | Clear | No Smell | 1.5±0.6 | 26.7±0.3 |
| 500maway | Tasteless | clear | No smell | 1.4±0.8 | 26.0±0.4 |

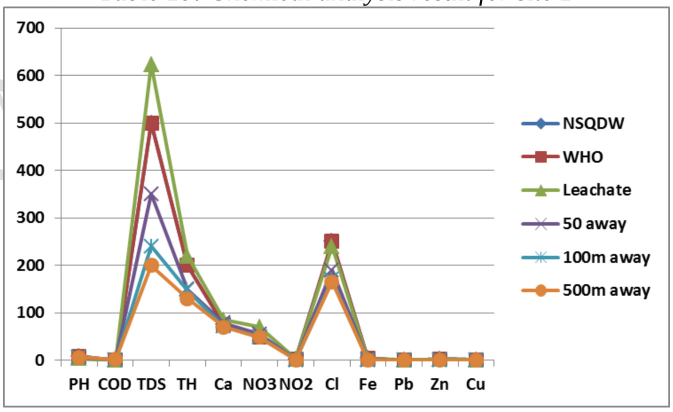
*Table 1a: Physical analysis result for site 1*




*Graph 1a: Graph of physical analysis result for site 1*

| Sample | PH | COD | TDS | TH | Ca | $NO_3$ | $NO_2$ | Cl | Fe | Pb | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSQDW | 6.5-8.5 | NS | 500 | 200 | 75 | 50 | 3 | 250 | 5.0 | 0.01 | 3.0 | 1.0 |
| WHO | 6.5-8.5 | NS | 500 | 200 | 75 | 50 | 3 | 250 | 5.0 | 0.01 | 3.0 | 1.0 |
| Leachate | 3.98 ±0.3 | 0.2± 0.5 | 623±0 .6 | 220 ±0. 1 | 85 ±0. 9 | 70± 0.3 | 2.8± 0.3 | 240± 0.3 | 3.0± 0.8 | 1.5±0 .6 | 2.2± 0.3 | 1.1± 0.1 |
| 50m | 5.50 ±0.5 | 0.8± 0.8 | 350±0 .9 | 150 ±0. 3 | 75 ±0. 3 | 55± 0.7 | 1.0± 0.4 | 190± 0.2 | 1.2± 0.3 | 0.2±0 .8 | 0.4± 0.9 | 0.2± 0.2 |
| 100m | 6.67 ±0.8 | 1.5± 0.2 | 240±0 .3 | 148 ±0. 4 | 71 ±0. 5 | 50± 0.1 | 0.9± 0.5 | 170± 0.3 | 1.1± 0.7 | 0.1±0 .3 | 0.2± 0.8 | 0.1± 0.2 |
| 500m away | 6.85 ±0.9 | 2..1 ±0.7 | 200±0 .5 | 130 ±0. 3 | 70 ±0. 2 | 49± 0.3 | 0.7± 0.2 | 165± 0.8 | 1.0± 0.9 | ND | ND | ND |

*Table 1b: Chemical analysis result for site 1*




*Graph 1b: Graph of chemical analysis result for site 1*

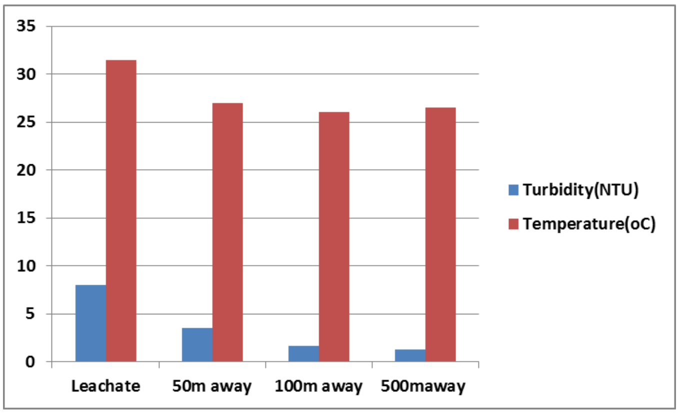
| Sample | 0 | 1-10 | 11-50 | >50 |
|---|---|---|---|---|
| Leachate | - | - | - | + |
| 50m away | - | - | + | - |
| 100m away | - | + | - | - |
| 500m away | + | - | - | - |

*All units are in 10/100ml MPN*

*Table 1c: Indicator bacteria (e coli) count result for site 1*

| Sample | Taste | Colour | Smell | Turbidity (NTU) | Temperature($^oC$) |
|---|---|---|---|---|---|
| Leachate | Not tasted | Not clear | Pungent smell | 8.0±0.3 | 31.5±0.4 |
| 50m away | Tasteless | clear | No smell | 3.5±0.5 | 27.0±0.3 |
| 100m away | Tasteless | clear | No smell | 1.7±0.8 | 26.0±0.6 |
| 500maway | Tasteless | clear | No smell | 1.3±0.2 | 26.5±0.7 |

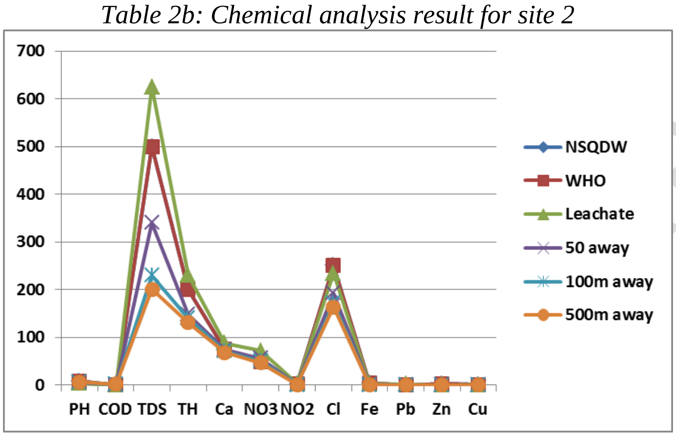
*Table 2a: Physical analysis result for site 2*




*Graph 2a: Graph of physical analysis result for site 2*

| Sample | PH | COD | TDS | TH | Ca | $NO_3$ | $NO_2$ | Cl | Fe | Pb | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSQDW | 6.5-8.5 | NS | 500 | 200 | 75 | 50 | 3 | 250 | 5.0 | 0.01 | 3.0 | 1.0 |
| WHO | 6.5-8.5 | NS | 500 | 200 | 75 | 50 | 3 | 250 | 5.0 | 0.01 | 3.0 | 1.0 |
| Leachate | 3.96±0.3 | 0.2±0.4 | 625±0.2 | 230±0.5 | 88±0.3 | 72±0.6 | 2.9±0.8 | 235±0.1 | 3.2±0.4 | 1.6±0.2 | 2..5±0.5 | 1.2±0.7 |
| 50m | 5.60±0.8 | 0.9±0.7 | 340±0.5 | 148±0.7 | 74±0.8 | 56±0.7 | 1.1±0.3 | 193±0.7 | 1.4±0.2 | 0.1±0.7 | 0.5±0.8 | 0.3±0.2 |
| 100m | 6.80±0.7 | 1.6±0.5 | 230±0.6 | 140±0.4 | 71±0.9 | 51±0.4 | 0.9±0.5 | 172±0.2 | 1.2±0.4 | 0.1±0.1 | 0.1±0.3 | 0.2±0.5 |
| 500m | 6.90±0.6 | 2.0±0.4 | 201±0.9 | 130±0.8 | 68±0.1 | 47±0.9 | 0.8±0.6 | 164±0.4 | 1.0±0.3 | ND | ND | ND |

*Table 2b: Chemical analysis result for site 2*




*Graph 2b: Graph of chemical analysis result for site 2*

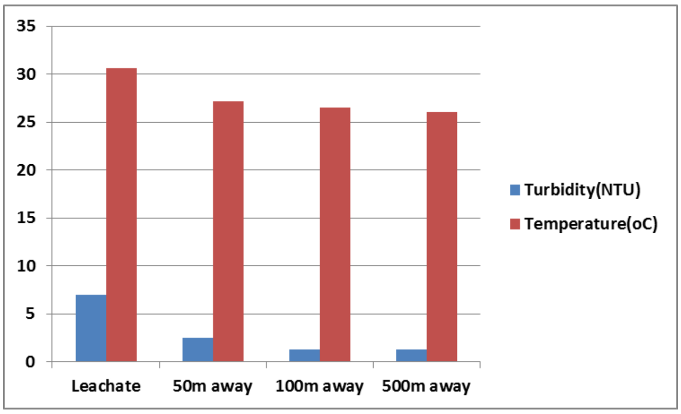
| SAMPLE | 0 | 1-10 | 11-50 | >50 |
|---|---|---|---|---|
| Leachate | - | - | - | + |
| 50m away | - | - | + | - |
| 100m away | - | + | - | - |
| 500m away | + | - | - | - |

All units are in 10/100ml MPN

*Table 2c: Indicator bacteria (e coli) count result for site 2*

| Sample | Taste | Colour | Smell | Turbidity(NTU) | Temperature(°C) |
|---|---|---|---|---|---|
| Leachate | Not tasted | Not clear | Pungent smell | 7.0±0.5 | 30.6±0.8 |
| 50m away | Tasteless | Clear | No smell | 2.5±0.8 | 27.2±0.6 |
| 100m away | Tasteless | Clear | No smell | 1.3±0.6 | 26.5±0.9 |
| 500m away | Tasteless | Clear | No smell | 1.3±0.3 | 26.0±0.2 |

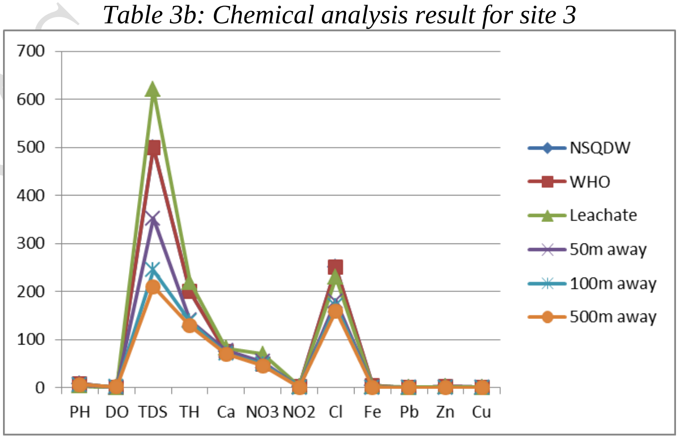
*Table 3a: Physical analysis result for site 3*




*Graph 3a: Graph of chemical analysis result for site 3*

| Sample | PH | DO | TDS | TH | Ca | $NO_3$ | $NO_2$ | Cl | Fe | Pb | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSQDW | 6.5-8.5 | NS | 500 | 200 | 75 | 50 | 3 | 250 | 5.0 | 0.01 | 3.0 | 1.0 |
| WHO | 6.5-8.5 | NS | 500 | 200 | 75 | 50 | 3 | 250 | 5.0 | 0.01 | 3.0 | 1.0 |
| Leachate | 3.97±0.5 | 0.1±0.3 | 620±0.8 | 220±0.6 | 82±0.3 | 70±0.2 | 2.7±0.5 | 230±0.1 | 3.0±0.8 | 1.4±0.3 | 2.1±0.5 | 1.0±0.6 |
| 50m | 5.63±0.8 | 0.9±0.7 | 352±0.5 | 140±0.9 | 74±0.7 | 54±0.1 | 0.9±0.9 | 180±0.4 | 1.1±0.9 | 0.1±0.4 | 0.2±0.7 | ND |
| 100m | 6.82±0.2 | 1.7±0.5 | 245±0.4 | 138±0.7 | 71±0.6 | 50±0.8 | 0.8±0.6 | 170±0.2 | 1.0±0.3 | ND | ND | ND |
| 500m | 6.95±0.3 | 2.2±0.4 | 210±0.1 | 129±0.3 | 69±0.2 | 46±0.6 | 0.7±0.4 | 160±0.8 | 0.9±0.5 | ND | ND | ND |

*Table 3b: Chemical analysis result for site 3*




*Graph 3b: Graph of chemical analysis result for site 3*

| Sample | 0 | 1-10 | 11-50 | >50 |
|---|---|---|---|---|
| Leachate | - | - | - | + |
| 50m away | - | + | - | - |
| 100m away | + | - | - | - |
| 500m away | + | - | - | - |

*Table 4.3c: Indicator bacteria (e coli) count result for site 3*

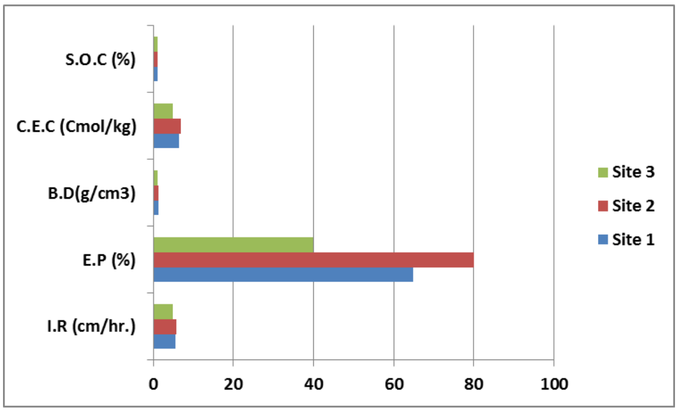
All units are in 10/100ml MPN

According to WHO any value above 1-10/100ml is not hygienic for drinking.

*NOTE:* + indicates detected, while **–** indicates undetected. E.coli was the indicator bacteria because of the temperature and time of incubation which is favourable for its survival

| Sample | I.R (cm/hr.) | E.P (%) | B.D(g/cm$^3$) | C.E.C (Cmol/kg) | S.O.C (%) |
|---|---|---|---|---|---|
| Site 1 | 5.6±0.8 | 65 | 1.23±0.2 | 6.54±0.1 | 1.14 |
| Site 2 | 5.8±0.7 | 80 | 1.25±0.3 | 6.89±0.5 | 1.10 |
| Site 3 | 5.0±0.4 | 40 | 1.01±0.6 | 4.93±0.8 | 1.01 |

*Table 4.4: Soil analysis result for all the dump sites*




*Graph 4:4: Graph of soil analysis result for all the dump sites*

## VI. DISCUSSIONS

### PHYSICAL RESULT ANALYSIS

The results as represented in tables 1a, 2a and 3a shows the levels of the various physical parameters tested in the water samples as collected from the different dumpsites.

From the result tables, it will observed that all the water samples from the different sites were colourless, odourless and tasteless which conforms to basic characteristics of drinking water which is quite different from the leachate which is the pollutant that had pungent smell and cloudy colour signifying that not all the content of the leachate infiltrated into the underground water .The turbidity value ranging from 1.0NTU to 3.5NTU in all the three sites were below the WHO accepted maximum value of 5 NTU for drinking water but the values being greater than one signifies the presence of suspended particles which may have percolated into the underground water through sediments though the quantity may not really have adverse health impact but its accumulation in the body may lead to cardiovascular and gastro intestinal disorders also it causes formation of sludge at the bottom of storage containers. From the table it can be observed that the temperature ranged from 26.0$^{o}$C to 27.8$^{o}$C in all the sites indicates the presence of active microorganisms and foreign bodies which must have led to the unprecedented increase in temperature highly above normal 3$^{o}$C to 8$^{o}$C recommended acceptable temperature range for drinking water according to WHO. This high temperature makes the water unfit for chemical analysis and could is slightly raise the body temperature when taken.

### CHEMICAL RESULT ANALYSIS

Analyzing the chemical parameters it would be observed from the tables 1b, 2b and 3b that the PH ranged from 3.98 to 6.95 in all the dump sites though site 1 has lowest PH of 3.98 when compared to others while site 3 has the highest PH of 6.95 signifying it is the least acidic. The relative high acidity observed in the underground water could be as a result of the presence of metals like iron, lead, copper generated from dumped batteries, aerosol containers, paints and metal scraps which would increase the number of hydrogen iron leading to increase in the acidity of the water though the normal acceptable PH range is between 6.5 to 8.5. furthermore from the table it is pertinent to note that the closest underground water to the dumpsites being 50m away for all the sites has the lowest Chemical oxygen demand (COD) value which ranged from of 0.8mg/L to 0.9mg/L when compared to other values obtained from distances of 100m away and 500m away in all the three sites that ranged from 1.5mg/L to 2.2mg/L. This indicates the presence of active aerobic microorganism which keeps on assimilating the available oxygen thereby depleting it and rendering the water unsafe for drinking. The Total dissolves solids (TDS) having values ranging from 200mg/L to 352mg/L indicates the presence of suspended particles though invisible to the naked eyes and well below the WHO accepted recommended value of 500mg/L. will still require some level of purification but it can be observed that the values for site 3 is a little above other sites. Therefore, the dumpsite may not directly be responsible for the increase in TDS as there is an excavation site close to site 3 which may possibly be responsible for the higher values obtained there. From chemical parameter tables it can be observed that total hardness (TH) ranged from 129mg/L in site 3 to 150mg/L in site 1. Total hardness signifies the presence of some ions magnesium and calcium ions which causes hardness of water leading to furring of kettle and inability of soap to ladder .This can be treated by boiling the water to remove temporary hardness or addition of calcium salt .Hard water taste good when taken also it helps in the formation of bones and teeth so the values obtained from the result which is below NSQDW maximum value of 200mg/L has no health implication rather it has health benefit but when in excess can cause cardiovascular diseases. From the table it can be observed that calcium levels ranged from 68mg/L in site 2 to 75mg/L in site 1, which are all within the acceptable WHO level in all the three sites when compared to acceptable range though calcium has many health benefits like bone and teeth formation but when in excess it can cause oedema (fluid buildup) and hypercalemania. The presence of calcium could have resulted from the waste especially bones generated by abattoirs close to the sites and also from gypsum rocks that are embedded in the earth crust. From table 1b, 2b and 3b it can be observed that nitrate and nitrite which ranged from 46-56mg/L and 0.7-1.1mg/L shows that all the values were high above the recommended value apart from the distances of 500m away in all the sites that ranged from 46mg/L to 49mg/L. The high levels of nitrate are not healthy for consumption because of its health impact as this can lead to methemoglobinemia also known as blue baby disease in children (nitrate displacing oxygen bound with hemoglobin thereby preventing the transport of oxygen). The nitrates which are usually abundantly found on soil surface and underground must have leached through the soil from fertilizers, decomposed organic matters, and excreta. The values of nitrites values in all the sites are well below the normal acceptable range of 3.0mg/L probably because it is an unstable compound that readily oxidizes to nitrates. Furthermore, from the table it can be observed that chlorine levels in all sites are all tolerable though chlorine helps in signal transduction, osmoregulation and helps in maintaining acid/base balance but high level of chlorine in water can give the water taste and lead to intestinal disorders and the irritation of the skin and eyes but . The presence of chlorine could have come from sodium chloride (salt) naturally found in water and some chlorine containing chemicals like aerosols, bleach etc. which must have leached through the soil. The levels of Iron from the result which ranged from 0.9mg/L to 1.4mg/L in the entire site which are acceptable though Iron has various functions in the body such as oxygen transport, good vision and boosting immunity but when in excess it can lead to liver disease (cirrhosis), cancer, diabetes mellitus, heart attack etc. The presence of Iron in the water could be from Iron scraps and containers dumped in the site. The presence of lead was only detected in those boreholes located close to the dumpsites namely, 50m away and 100m away respectively indicating its low infiltration rate and quantity in the dumpsite and. The presence of lead could be from lead pipes and containers, batteries, and gasoline products. Lead when consumed in excess can lead to health challenges like anemia, damage to baby's central nervous system kidney and brain damage because when it enters the body it is distributed to major organs like brain, kidney and liver. For zinc just like lead it was only detected in boreholes close to the dumpsite namely, 50m and 100m away boreholes respectively but for site 3 just 0.1mg/L was detected only in 50m away borehole. Their values are still permissible for drinking as it ranged from 0.5mg/L to 0.5mg/L. though small quantity of zinc in the body helps to build the body immune system, cell growth and division, healing of wounds and breakdown of carbohydrates but when in excess it may lead to low immunity, nausea, diarrhea, kidney and stomach damage. The presence of zinc in the water could be from disposed materials like roofing sheets, zinc containers etc. Finally, it can be observed from the chemical analysis result that copper was not detected in all the boreholes in site 3, all distances of 500m away in all the sites but were in negligible quantities ranging from 0.1mg/L to 0.3mg/L in site 1 and 2. Small quantities of copper in the body helps in prevention of cardiovascular diseases, production of red blood cells, maintaining nerve cells and immune system but when found in excess quantities in the body may lead to hypogonadism, nerve damage, stomach cramp and liver disease etc. The presence of copper in the water could be as result of scrap cables, foils, utensils and containers that may have deposited in the dump sites.

BACTERIOLOGICAL RESULT ANALYSIS

From tables 1c, 2c and 3c which shows the bacteriological analysis it can be observed that all the underground water within 50m away from the dumpsites except site 3 are highly polluted with e.coli bacteria as the levels are high above the WHO acceptable range of between 1/100MPN to 10/100MPN for drinking water to be considered hygienic. For site 3, the borehole located within 100m away from the dumpsites though e.coli was not detected to a high level but it still indicates some level of pollution, only the boreholes located far away from the dumpsites as from 500m away far away from the dump sites are considered safe because no e.coli was not detected in them. Drinking water contaminated with e.coli is unhygienic as it causes series of diseases like gastro intestinal disease and typhoid fever. The presence of the e.coli bacteria could have possibly come from feacal contamination and decomposed animals and other compounds etc. disposed in the dumpsites.

SOIL HYDRAULIC PROPERTIES ANALYSIS

From table 4 above showing soil properties, it can be observed that the I.R. that is soil infiltration rate(movement of water in the soil) is highest in site 2 having value of 5.8cm/hr. followed by site 1 that has the value of 5.6cm/hr. with site 3 having the least value of 5.0cm/hr. this could be the reason why site 2 has higher concentration of most of the chemical parameters analyzed as the infiltration rate could explain the reason why more contaminants infiltrated through the soil to the underground water . For the soil effective porosity (bulk volume of the soil not occupied by soil particles) just like soil I.R. it can be observed that site 2 also has highest value of 80% while site 3 has the least value of 40% this soil property shows the quantity of substances or compounds that can pass through the soil therefore indicating that site 2 has the highest tendency to allow compounds to percolate while site 3 has the least tendency for that. From table 4, it can be observed that the soil B.D (bulk density) that is the soil pores are relatively the same with values of $1.23g/cm^3$,$1.25g//cm^3$ and $1.01g/cm^3$ respectively though with slight differences it shows the space available for substances to pass through the soil is in the order of site 2 > site 1 > site 3. The soil C.E.C. (cation exchange capacity) shows the rate of displacement of cations such s $K^{+}$, $Ca^{2+}$, $Na^{+}$,$Al^{3+}$, $Zn^{2+}$,$Pb^{2+}$,$Fe^{2+}$ and $Cu^{2+}$ etc. in the soil it also follows the same trend with site 2 with value of 6.89 Cmol/kg having the highest tendencies of cations exchange. This probably accounts for the reason while the more reactive cations like $Ca^{+}$, $Mg^{2+}$ were more in concentration than the less reactive cations like $Zn^{2+}$,$Pb^{2+}$,$Fe^{2+}$ etc. Finally from the table it can be observed that the S.O.C (soil organic carbon) content that is the presence of organic matter in the soil is relatively the same with values of 1.01% in site 3 to 1.14% in site 1 which shows the available organic carbon in form of organic matter which are substrates for potential active microorganism which constitutes contaminants when it infiltrates into the underground water. The values are negligible therefore not complicit in the pollution of the underground water.

## VII. CONCLUSION/RECOMMENDATION

This study has shown that the underground water which is the major source of borehole water in almost all the household and commercially sold sachet water in Owerri municipalities has some level of pollution with those close to dump sites mostly affected and unhygienic for consumption as they have traceable concentrations of some toxic compounds like nitrates, nitrite, iron, lead copper etc. which are likely to cause diseases like cardiovascular diseases, liver cirrhosis, cancer and respiratory disorder also with the presence of active microorganisms like e.coli which is the causative bacteria for many diseases like typhoid fever, gastro intestinal infection ,diarrhea etc. it therefore constitutes health risk to drink such water without purification as most of the waste from the dumpsites infiltrates through the soil to the underground water and the level of infiltration of the pollutants is also dependent on the hydraulic properties of the soil and the direction of water flow as areas within the southern part of the municipality are more prone to contamination than the northern region. Therefore it is also pertinent to seek the services of professional geologists and soil scientist before drilling boreholes especially in areas prone to environmental pollution also there should be public enlightenment on proper sorting and disposal of waste. Furthermore high volume dumpsites should be sited very far away from residential areas. People should also adopt different purification methods before drinking water such as filtration, reverse osmosis and deionization especially for water highly contaminated with metals, distillation, boiling etc. as this will reduce the level of contamination in the water. Also government should encourage the use of modern waste disposal methods like use of inclinators, recycling to reduce the volume of waste generated and the use of sanitary landfills with cemented slabs to mitigate the level of further indiscriminate pollution of underground water.

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## REFERENCES

[1] Akala, C.O. (2006). Hawked Water Quality and its Health Implications in imo, Nigeria. Botswana J. of Technol, 2006, 15(2): 70-75. http://www.ajol.info/bjt

[2] Akinbile, C.O. and Alatise, M.O (2011). Qualitative Analysis of Bored Groundwater for Agricultural and Municipal uses in Ondo state, Nigeria, J. of Agric, Sci. and Technol, Makurdi (in press).

[3] Akinbile, C.O. and Yusoff, M.S. (2011). Environmental impact of leachate pollution on groundwater supplies in akure, Nigeria. International. J. of environ sci, and technol, devlpmt, 2(1): ISSN: 2010-0264.

[4] Al Sabahi, E., Abdul Rahim, S., Wan Zuhairi, W.Y., Al Nozaily, F. and Alshaebi, F., (2009). 'The Characteristics of Leachate and Groundwater Pollution at Municipal Solid Waste Landfill of Ibb City, Yemen', Amer. J. of Environ. Sci, 5 (3): 256-266.

[5] APHA (2005). Standard Methods for the Examination of Water and Waste Water, twenty first ed. American Public Health Association, Washington, DC.

[6] City watch Population (NIDI). Owerri Municipal (Local Government Area). Retired httph/www.citypopulation.de/ php/nigeriaadmin.php?adm21d=NGAO17026

[7] Dan'azum, S. and Bichi, M. H. (2010). Industrial Pollution and Implication on Source of Water Supply in Kano, Nigeria. Inter. J. of Engr'g and Technol. IJET-IJENS, 10 (1): 101-110

[8] Dissanayake, P. Clemett, A. Jayakody, P. and Amerasinghe, P. (2010). Water quality survey for Kurunegala, Sri Lanka, summary assessment of wastewater agriculture and sanitation for poverty alleviation (WASPA) in Asia, pp 1 - 4.

[9] Encyclopedia Britannica (2009). Owerri, Nigeria, Retrieved https://www.britannica.com/plaie/ owerri

[10] Igbinosa, E.O. and Okoh, A.I. (2009). Impact of discharge wastewater effluents on the physic-chemical qualities of a receiving watershed in a typical rural community, Inter. J. of Environ. Sci. and Technol, 2009, 6 (2): 1735 – 1742.

[11] Ikem, A., Osibanjo, O., Sridhar, M.K.C. and Sobande, A. (2002). 'Evaluation of Groundwater Quality Characteristics near Two waste Sites in Ibadan and Lagos, Nigeria', Water, Air, and Soil Poll, 140: 307–333. Kluwer Academic Publishers, the Netherlands.

[12] Jaji, M.O., Bamgbose, O., Odukoya, O. O. and Arowolo, T.A. (2007). Water quality assessment of Ogun River, south west Nigeria. Environ. Monit. and Assess, 133, 473-482.

[13] Longe, E.O. and Balogun, M.R. (2010). 'Groundwater Quality Assessment near a Municipal Landfill, Lagos, Nigeria', Research J. of Applied Sci, Engr'g and Technol, (1): 39-44.

[14] Mohamed, A. F., Yaacob, W.Z.W., Taha, M.R. and Samsudin, A.R. (2009). 'Groundwater and Soil Vulnerability in the Langat Basin Malaysia'. Euro. J. of Sci. Res, 27(4):628-635

[15] NSDQW (2007). Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard NIS 554, Standard Organization of Nigeria, pp: 30.

[16] Ogede, K. and Akubue, C. O. (2004). Impact of Industrial Pollutants on Quality of Ground and Surface waters at works Industrial Estate, owerri, Nigeria, Nigerian J. of Technol Dev, 2004. 4 (2): 139-144

[17] Ogede, K. and Akubue, C. O. (2007). Wellwaters Disinfection by Solar Radiation in Ibadan, Nigeria, Nigerian Journal of Technological Development, 5 (1): 39- 47. Owerri, Nigeria.

[18] Olasanye, O.O and Ilomuanya, O.A. (2009). Waste to Wealth; A case study of the imo State Integrated Waste Recycling and Treatment Project, Nigeria. Euro. J. of Social Sci, 8(1): 7 – 14.

[19] Sangodoyin, A.Y. (1991). Ground Water and Surface Water Pollution by Open Refuse dump in Ibadan, Nigeria, Dis. and Inno. Vol 3, No 1, pp. 24 - 31.

[20] Shyamala, R., Shanti, M., and Lalitha, P. (2008). Physicochemical Analysis of Borewell Water Samples of Telungupalayam Area in Coimbatore District, Tamilnadu, India, E-J. of Chem, 5 (4): 924-929.

[21] Srinivasamoorthy, K., Chidambaram, S., Sarma, V.S., Vasanthavigar, M. Vijayaraghavan, K. Rajivgandhi, R. Anandhan P. and Manivannan, R. (2009). 'Hydro

geochemical Characterization of Groundwater in Salem District of Tamilnadu, India', Res. J. of Environ. and Earth Sci. 1(2): 22-33.

[22] WHO, (2004). Guidelines for Drinking Water Quality. 3rd Edition, Vol. 1. Recommendation, Geneva, 515.

[23] World Health Organization. (2006). WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater: Volume II wastewater use in.