

# Hydrochemical and Electrical Resistivity Assessment of a Refuse Dumpsite within Olorunda Community, Ado-Ekiti, Southwestern Nigeria

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**Abstract**— Sequel to various reports of incessant complaint of water pollution around the refuse dumpsite, this research work was conducted with the aim of proffering a timely solution to the problems before it escalated to epidemic. Surface DC resistivity and hydro chemical techniques were used to identify the various lithological layers, delineate groundwater contaminant plumes and assess the risk level of groundwater pollution within the study area. Eight vertical electrical sounding (VES) were conducted and the data obtained were interpreted quantitatively by partial curve matching and electronically iterated using WINRESIST computer iteration program. The apparent resistivity ranges from 108.3 - 4844.4Ωm, VES 7 has the lowest value of 108.3Ωm while VES 3 has the highest apparent resistivity value of 4844.4Ωm. The result of the hydro chemical analyses of the water from the study area was compared with the World Health Organization (WHO) standard. This revealed that the average values are Cl (70.42mg/l), Fe (0.268mg/l), Mn (0.214mg/l) and SO<sub>4</sub> (890.9mg/l) parameters fall within the acceptable WHO standard. However, Chromium (Cr) value obtained from the stream water might have resulted from refuse through dumps or from the country rock that the groundwater had contact with. Through the low resistivity values observed from this study area and the presence of opportunistic elements (ions) in the water, it indicates that geophysical and hydro chemical analysis can be integrated to know the effect of dumpsite on an underlying groundwater.

**Keywords**— Chromium, Resistivity, Winresist, Plumes, Iteration.

## I. INTRODUCTION

The environmental degradation caused by improper disposal of waste can be experienced in the contamination of groundwater (USGS, 2014) through infiltration of leachate. Dumpsite location within an urban environment create primary concern particularly where a larger population depends on groundwater for their domestic activities (Visvanathan and Ulrich, 2006). In Ado-Ekiti, Nigeria, groundwater serves as a major source of potable water for the population at large. Since the quality of groundwater is more important than its quantity, there is need to study the possible effect(s) of the leachate emanating from dumpsites on the surrounding aquifer unit(s). Hence this study, carries out at Olorunda area of Ado Ekiti came to the fore.

In this work, the combination of physicochemical and electrical resistivity methods was employed to determine the level and extent of contamination to the water table by the

leachate from the waste disposal site. Previous research works were applied to characterization and delineation landfill (Olayinka and Barker, 1990; Carruthers and Smith 1992). Open refuse dumpsite (Marshal, 1995; Ojeshina, 1999) have constituted a major problem to the environment, mostly in developed and industrialized countries, due to waste generated complexity relative to increased development in science and technology and over blotted population. Inefficient solid waste management is characterized by poor collection system coverage (Ugwu and Nwosu, 2009; Ogwueleka, 2003) and improper disposal of solid waste (Badmus, *et al.*, 2001).

Resistivity method as a unique geophysical tool studies (Dahlin and Zhou, 2002) that has been used by several researchers to assess environmental problems (Ayolabi, 2005; Uchegbulam and Elijah, 2014) and groundwater studies (Ayolabi and Folashade, 2005) to evaluate landfill site and its implication on Groundwater. Geoelectric methods produce vertically and laterally migrating leachates (Ross, *et al.*, 1990) this commonly reduce resistivity, which can be delineate natural from non-saline (Afolayan *et al.*, 2004) groundwater. Therefore, materials containing contaminated water will possess low resistivity than materials containing unaffected groundwater (Barker, 1990). It is possible to map the extent of contamination, if the water table is fairly shallow and the subsurface is relatively homogeneous (Olubanji *et al.*, 2013). Generally, geophysical methods provide economic and non-destructive means to investigate contaminant plumes from landfills (Carpenter *et al.*, 1990; Rosqvist *et al.* 2003), capable of mapping fracture zones (Olayinka and Barker, 1990; Carruthers and Smith 1992) and landfills.

Groundwater pollution results from anions and cations (Osazuwa and Abdullahi, 2008) increased concentration (Cu<sup>2+</sup>, Fe<sup>2+</sup>, Zn<sup>2+</sup>, NO<sup>3-</sup>.) present. In recent, the impact of leachate on groundwater and other water resources has attracted a lot of attention because of its overwhelming environmental significance (Olayinka and Olorunfemi, 1992; Bayowa *et al.*, 2012). Combined geoelectric measurements, (Barker, 1990) hydrogeological and chemical (Abubakar and Danbatta, 2012) analysis of water samples are often used to identify the underground aquifers, estimate porosity and permeability of geologic materials, assess groundwater quality, direction of groundwater flow and spread and possible migration paths of

contaminants (Porsani *et al.*; 2004) in a polluted area. Improper Waste disposal has generally led to proliferation of pathogenic microbes and heavy metals within an environment (Ugbaja and Edet, 2004) mostly soil and aquatic environments. Anthropogenic factors contribute highly to contamination of both surface (Hussain *et al.*, 1989); and underground (Singh *et al.*, 2008) water.

There have been increased concerned about lead and other heavy metals mainly from lead as anti-knock additive to petrol (Ipinmoroti *et al.*, 1970) and metal based fertilizers (Adefemi and Awokunmi, 2009) in the government agricultural revolution. Arsenic (As), Chromium (Cr) and Copper (Cu) has been discovered to be associated with sludge incineration (Bou-Zeid and El-Fadel, 2004), municipal solid wastes, building materials and possibly be introduced through high tension electricity supply lines. The unrestrained disposal of lead (Olorunfemi and Fasuyi, 1993), batteries and used petroleum products around Ojota, Lagos could probably increase lead (Ugbaja and Edet, 2004), copper and iron poisoning level within the environment which could cause epidemics through drinking (Marshall, 1995) or inhalation (Edet, 1993)

This present study calls to conduct an assessment on the refuse dumpsite and the groundwater resources around Olorunda, Ado Ekiti, Nigeria in order to determine the concentration level of contaminants and their impact on the quality of groundwater within they environment. The hand-dug wells in this area was located within a distance of 3 to 25m radius around the waste disposal site with their depths ranging from 3.5 to 5m. The researched site has been in existence for over fifteen years covering an area of about 30 to 50 square meters with the refuse content consisting of various types of materials ranging from metallic, organic to non-biodegradable materials.

## II. GEOLOGICAL SETTINGS OF THE STUDY AREA

The study area is situated within Ado-Ekiti, Southwestern basement complex, Nigeria, with coordinates: Latitude 7° 33' and 7° 42' N and Longitude 5° 11' and 5° 20' E, respectively, it is located in a low-lying terrain surrounded with isolated hills, ridges and inselbergs. Geologically the rocks belong to the basement complex of south western Nigeria. This consists of the migmatite suites, the older granite suites (Rahaman, 1988) the meta sediments, the diorite, dolerite and granodiorite suites and the younger granites. These occurs during series of orogenic episodes coupled with weathering of preexisting rocks. The geology of Ado-Ekiti belongs to the basement complex (igneous rock) rock of South Western Nigeria. Major lithological rock units are basically crystalline Basement rocks. These include coarse grained charnokite, fine grained granite (Woakes *et al.*, 1987) medium grained-granite and porphyritic biotite-hornblende granite. The topography is relatively low with isolated hills and inselbergs that are dome-shaped. At the base of these rocks are boulders littering all over the place (Ayoade, 1982).

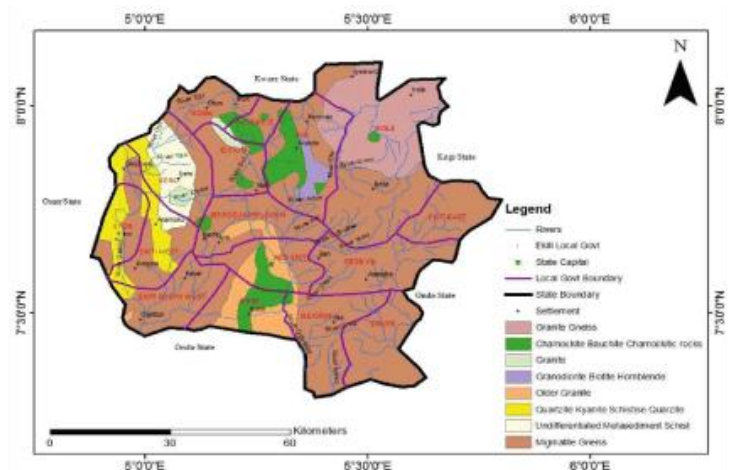


Fig. 1. Geological map of Ado-Ekiti (After Abubakar and Danbatta, 2012)

The area is underlain by the Precambrian basement complex rocks of Southwestern Nigeria (Rahaman and Ocan, 1978) and drained by River Ireje, Elemi, Omisanjana and Awedele Stream. These rivers flow into River Ose and River Owena and empty into the Atlantic Ocean (Rahaman, 1988). The study area is located at Olorunda/Olorunsogo Road, Off Nova Road, Adabayo Ado-Ekiti. It lies between longitude 07°39' N and latitude 005°13' E

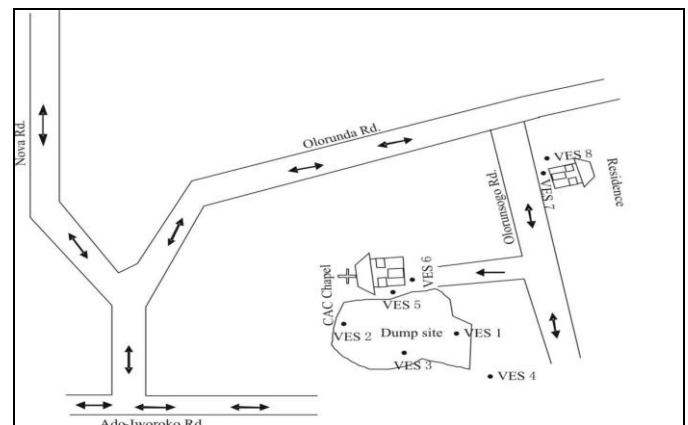


Fig. 2. Base map of study area

## III. MATERIALS AND METHODS

Vertical electrical sounding (VES) and geochemical analysis were conducted to prospect for water bearing formation and groundwater contamination around the dumpsite using the ABEM WADI (SAS 1000B) terameter and Atomic Absorption Spectrometer (AAS), Buck Scientific model 210 VGP & Flame photometer FP 902 PG, coupled with the calibration plot method. The equipment used during the sample collections include: hammer, connecting cable, global positioning system (GPS), tape rule, recording sheet, reel of calibrated rope.

The Schlumberger array whereby potential electrode remain fixed while the current electrode is expanded simultaneously about the centre of spread were used (where  $AB = MN/2$ ).

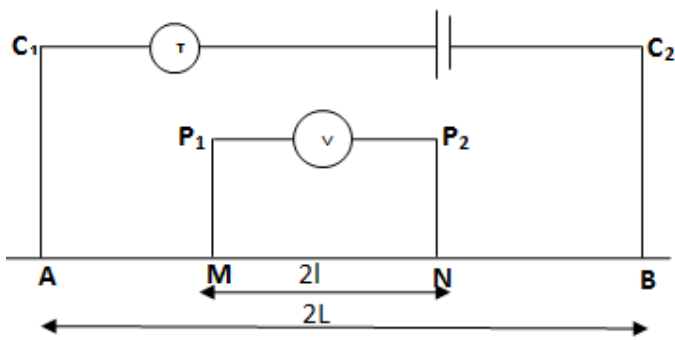


Fig. 3. Schlumberger array

study area. The data obtained from the electrical resistivity survey were subjected to qualitative and quantitative analysis (Table 4.1).

TABLE 4.1. Ves Location and Coordinates

VES NO.	NORTHINGS (x)	EASTINGS (y)	ELEVATION (z)
VES 1	07°39'56"	005°13'31"	400m
VES 2	07°39'56"	005°13'31"	423m
VES 3	07°39'55"	005°13'31"	420m
VES 4	07°39'56"	005°13'31"	384m
VES 5	07°39'55"	005°13'30"	389.1m
VES 6	07°39'55"	005°13'31"	389.2m
VES 7	07°39'56"	005°13'28"	391.4m
VES 8	07°39'56"	005°13'27"	394.9m

A. Sample Collection and Geochemical Analysis

Six borehole water samples were collected close to the dumpsite. The samples were carefully collected in a washed and sterilized sample container and properly labeled to avoid contamination. Measurement of physical properties such as pH, Electrical conductivity, Hardness, Total Dissolve Solid and Temperature were conducted at the point of sampling. The samples were taken to the laboratory for major Elemental and heavy metal analyses following (Greenberg *et al.*, 1985) procedures. The samples were analyzed with Atomic Absorption Spectrophotometer (AAS) Buck Scientific model 210 VGP and Flame photometer FP 902 PG both for heavy metal and chemical analysis

The results of the VES data were presented as curves, and was plotted on a bi-log graph. Initial interpretation of the eight VES curve were done by partial curve matching using a master curve and its auxiliary curves (A, H, K and Q curves) and final interpretation on computer iteration with the aid of win Resist 2 software. This was used to generate a geo electric section of the subsurface. Computer iteration was carried out on the data obtain from field (VES 1- VES 8), this shows the number of layers, resistivity of each layers, thickness of the layers and the depth of the layers. The seventh and eighth VES used as the Control VES which were taken at about 70m away from the dumpsite to observe the difference in resistivity properties.

IV. RESULTS AND DISCUSSION

A total of eight (8) Vertical Electrical Sounding (VES) measurements were conducted within the dumpsite at the

TABLE 4.2. Field Resistivity Data for VES 1 - VES 8

AB/2 (M)	MN/2 (M)	K	VES 1 (ΩM)	VES 2 (ΩM)	VES 3 (ΩM)	VES 4 (ΩM)	VES 5 (ΩM)	VES 6 (ΩM)	VES 7 (ΩM)	VES 8 (ΩM)
1	0.25	5.89	143	51	282	181	125	135	88	108
2	0.25	24.74	173	48	118	244	134	137	89	72
3	0.25	56.16	174	50	178	250	176	113	49	79
4	0.25	100.15	158	61	254	200	186	107	104	80
6	0.25	225.83	131	52	320	168	172	76	88	112
6	0.5	112.33	140	62	463	177	181	85	100	78
8	0.5	200.30	106	60	400	145	109	81	115	93
12	0.5	451.66	168	64	684	82	121	143	150	173
15	0.5	706.16	244	44	1470	124	197	186	141	162
15	1	351.90	129	103	848	123	175	148	147	162
20	1	626.83	156	65	1389	125	226	232	149	250
30	1	1412.33	217	67	1784	169	201	348	166	470
40	1	2512.03	418	74	-	209	334	426	209	471
40	2.5	1001.51	333	-	-	-	-	-	-	---
50	2.5	1567.07	342	-	-	-	-	-	-	-

Table 4.2 below shows the resistivity field data obtained from the study area. The interpretation of field resistivity data is in terms of resistivity, depth to bedrock and interfaces across which a strong electrical contrast exists as shown by the geoelectric section (Fig.). The electrical resistivity varies between different materials, depending mainly on variation in the water contents and dissolved ions in the water. The analysis and interpretation of the survey data showed different geoelectric layers. Two particular type of sounding curve (4 - layer QH type and a 3 layer H curve) were obtained from the study area.

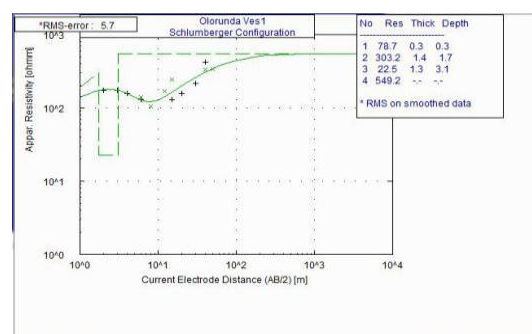


Fig. 4.1. Showing Computer Iteration of VES 1

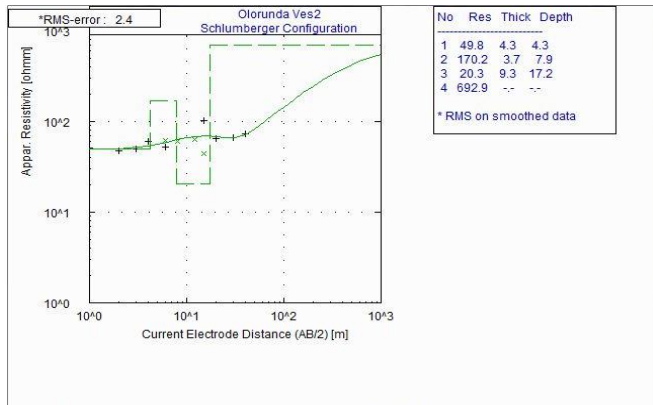


Fig. 4.2. Showing Computer Iteration of VES 2

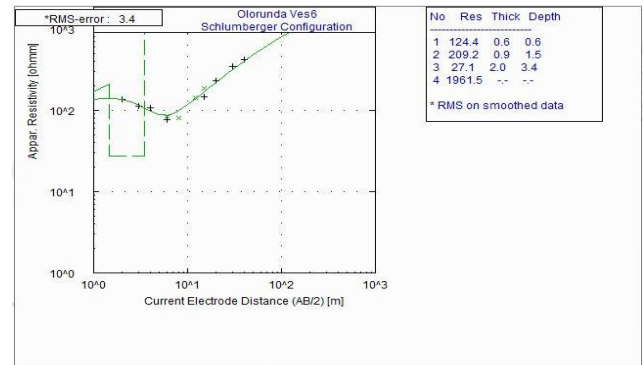


Fig. 4.6. Showing Computer Iteration of VES 6

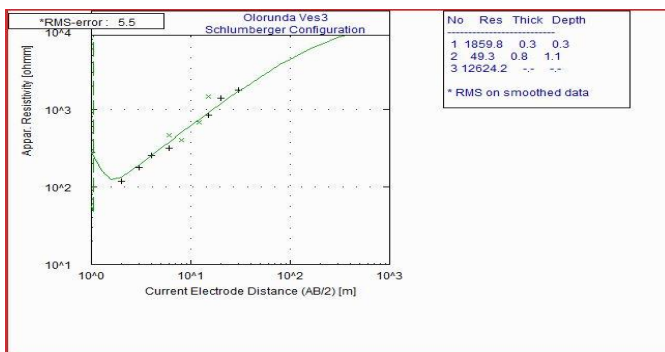


Fig. 4.3. Showing Computer Iteration of VES 3

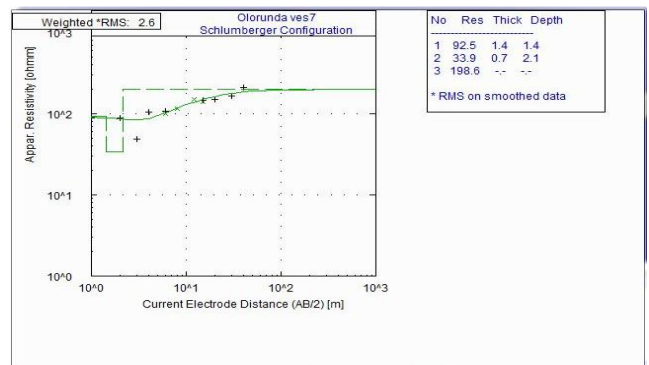


Fig. 4.7. Showing Computer Iteration of VES and VES 8 7

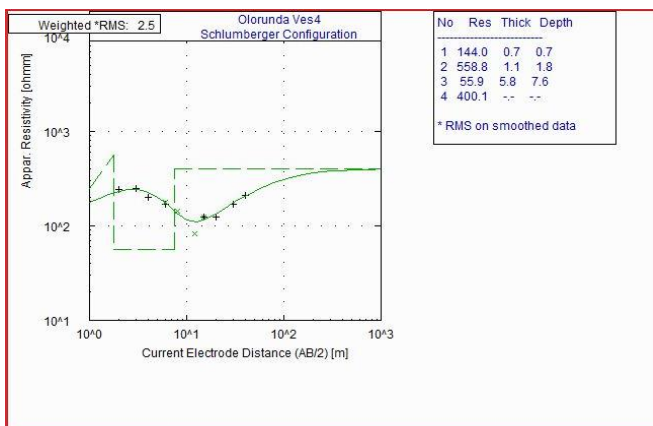


Fig. 4.4. Showing Computer Iteration of VES 4

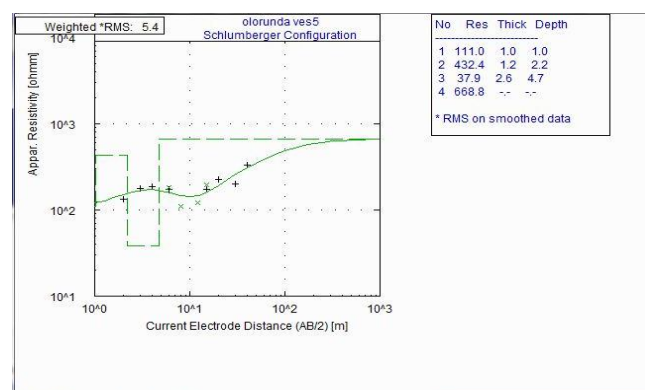
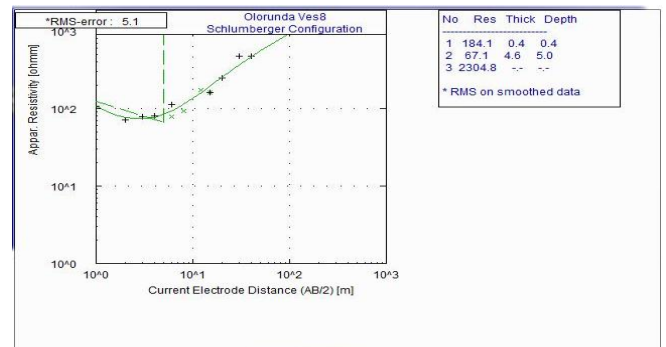


Fig. 4.5. Showing Computer Iteration of VES 5

The QH type is predominant in the area. These curve types are usual pointers to the possibility of the occurrence of groundwater in the basement Complex of Nigeria (Olayinka and Olorunfemi, 1992; Olorunfemi and Fasuyi, 1993) Details of the geoelectric parameters of each VES is presented in table 4.3. The resistivity values obtained ranges from 14Ωm to 2231Ωm. The geoelectric section shown in Fig. above has a distinct three to four (3-4) geoelectric layers which can be identified on the section. The first layer Lateritic top soil with resistivity values varying between 49.8 and 1859.8Ωm and the layer thickness values between 0.0 and 5.0m was associated with the topsoil. The second layer with resistivity values ranging between 20.3 and 692.9Ωm and depth to base of the layer ranges between 1m and 8m was referred as the Sandy Clay.

TABLE 4.3. Summary of Interpreted VES Curves

VES No.	Layer No.	Resistivity ( $\Omega m$ )	Thickness (m)	Depth (m)	Lithology	Curve Types
1	1	78.7	0.3	0.3	Lateritic Top soil	QH
	2	303.2	1.4	1.7	Sandy Clay	
	3	22.5	1.3	3.1	Weathered Basement	
	4	549.2	$\infty$	> 3.1	Fresh/Fractured Basement	
2	1	49.8	4.3	4.3	Lateritic Top soil	QH
	2	170.2	3.7	7.9	Sandy Clay	
	3	20.3	9.3	17.2	Weathered Basement	
	4	692.9	$\infty$	> 17.2	Fresh/Fractured Basement	
3	1	1859.8	0.3	0.3	Lateritic Top soil	H
	2	49.3	0.8	1.1	Weathered layer	
	3	12624.2	$\infty$	> 1.1	Fresh Basement	
4	1	144.0	0.7	0.7	Lateritic Top soil	QH
	2	558.8	1.1	1.8	Sandy Clay	
	3	55.9	5.8	7.6	Weathered Basement	
	4	400.1	$\infty$	> 7.6	Fresh/Fractured Basement	
5	1	111.0	1.0	1.0	Lateritic Top soil	QH
	2	432.4	1.2	2.2	Sandy Clay	
	3	37.9	2.6	4.7	Weathered Basement	
	4	668.8	$\infty$	> 4.7	Fresh/Fractured Basement	
6	1	124.4	0.6	0.6	Top soil	QH
	2	209.2	0.9	1.5	Sandy Layer	
	3	27.1	2.0	3.4	Weathered Layer	
	4	1961.5	$\infty$	> 3.4	Fresh Basement	
7	1	92.5	1.4	1.4	Top soil	H
	2	33.9	0.7	2.1	Weathered Layer	
	3	198.6	$\infty$	> 2.1	Fresh Basement	
8	1	184.1	0.4	0.4	Top soil	H
	2	67.1	4.6	5.0	Weathered Layer	
	3	2304.8	$\infty$	> 5.0	Fresh Basement	

Goelectric Section

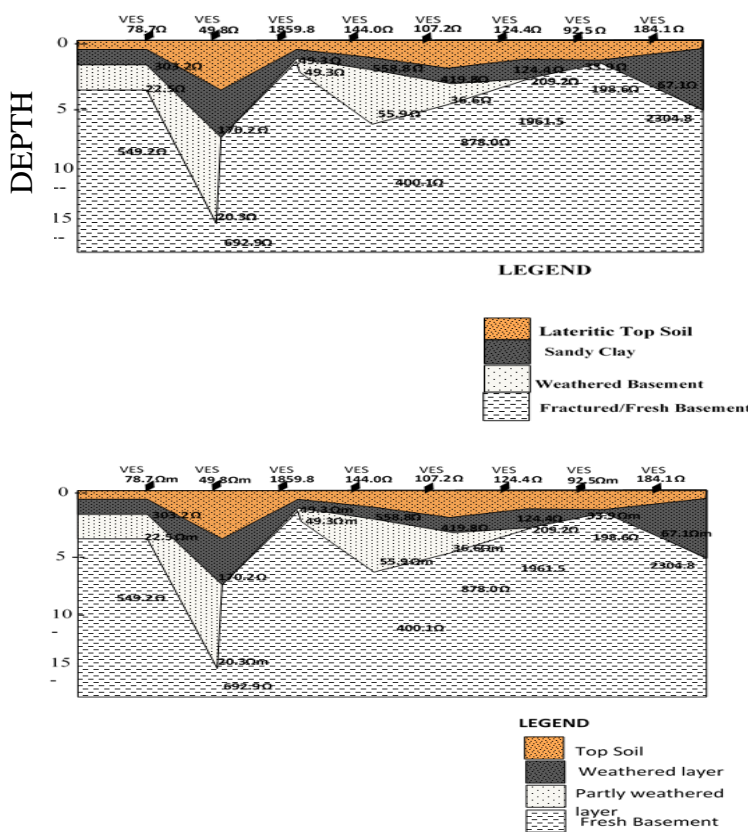


Fig. 4.9(a -b). Goelectric Section of the Study Area

The third layer was taken as the Weathered Basement with layer resistivity values range between 20.3 and 2304.8 $\Omega m$  within the depth of 3m-17m. The fourth layer was taken as the Fresh/Fractured Basement with resistivity values range between 400.1 $\Omega m$  and 1961.5 $\Omega m$  with the depth of 14 and 20m below the surface. Based on the depth of the wells in the study environment v ranging from 3.5 to 5.0 meters, it is indicated that all the well fall within the second layer of Sandy clay material.

Hydrochemical Result

The physiochemical analysis results of water samples are presented in tables respectively. The results were also correlated with the WHO (2006) water standard to see the possible impact that may be occurring in the study area.

**Total Hardness:** The total hardness of the water samples ranges from 399.6 - 769.6mg/l as against the WHO (2006) standard of 500mg/l. This implies that water from well 1, 2, 3, 4, 5 and stream are hard. The VES stations 1 and 2 which is close to well 1 and 2 with corresponding resistivity values of 238.4 $\Omega m$  and 233.3 $\Omega m$  respectively.

**P<sup>H</sup>:** The P<sup>H</sup> value of the well water samples ranges from 7.4 - 7.7mg/l compared with the WHO (2006) standard limit which ranges from 6.5 - 8.5mg/l. This implies that the samples from the study area are within the acceptable limit. The water is not acidic. When compared with the resistivity values, VES stations 1 and 2 has a pH value of 7.4 and 7.6 with a low resistivity value.

TABLE 4.5. Showing hydrochemical Results

SN	Parameter	Well 1	Well 2	Well 3	Well 4	Well 5	Stream	Mean	WHO (2006)
1	Mg	17.99	32.38	21.59	14.39	57.57	97.14	40.18	30-150
2	Ca	488.4	266.4	251.6	266.4	255.2	370.0	316.33	75-200
3	Total Hardness	562.4	399.6	340.4	325.6	592	769.6	468.27	100-500
4	PH	7.4	7.6	7.7	7.7	7.6	7.6	7.6	6.5 – 9.2
5	E. Conductivity	139.6	125.8	119.0	106.2	178.1	177.1	141.00	1500
6	Total dissolved solid	93.5	84.3	79.7	71.2	119.3	118.7	94.45	500
8	Chlorine	68.2	67.9	67.0	58.9	82.6	78.8	70.42	200
9	SO <sub>4</sub>	842.9	805.6	858.2	933.1	835.2	890.9	861.00	200-400
10	Total Alkalinity	80	100	70	110	270	260	148.33	
11	Sodium (Na)	21.600	17.050	33.500	28.500	41.350	52.050	32.341	

TABLE 4.6. Results from Heavy Metal Analyses

SN	Parameter	Well 1	Well 2	Well 3	Well 4	Well 5	Stream	Mean	WHO (2006)
1	Manganese (Mn)	0.139	0.208	0.198	0.176	0.296	0.268	0.214	0.05-0.5
2	Iron (Fe)	0.220	0.194	0.280	0.152	0.359	0.400	0.268	0.1-0.3
3	Lead (Pb)	0.001	0.001	0.001	0.002	0.001	0.005	0.002	0.05
4	Copper (Cu)	0.070	0.046	0.075	0.052	0.102	0.110	0.076	0.05-1.5
5	Chromium (Cr)	0.016	0.009	0.011	0.007	0.012	0.035	0.015	0.02
6	Nickel (Ni)	0.001	0.001	0.002	0.001	0.004	0.014	0.006	

**Total Dissolve Solid:** The total dissolve solid values in all the wells under study ranges from 71.2-119.3 which is within the WHO (2006) standard value of 500. In comparison with VES stations, 1, 2 and 7 it is discovered to have a low resistivity coupled with low total dissolved solid value.

**Electrical Conductivity:** The water from all the wells have Electrical conductivity (EC) that ranges from 106.2 - 178.1. This falls within the Electrical conductivity value of 1500 recommended by WHO (2006) standard. When correlated with the resistivity values, VES station 8 with a resistivity of 852Ωm has a relatively low electrical conductivity of 106.2μ/cm from well 5.

**Total Alkalinity:** The alkalinity content in water samples ranges between 70-270mg/l

**Sodium (Na):** Sodium content contained in the water samples analyse ranges from 17.05-52.05mg/l

**Magnesium (Mg):** The magnesium value of the water samples from well 1 - well 6 ranges from 74.0 - 399.6 mg/l. This value exceeds the acceptable limit of World Health Organization (2006) of 50mg/l. Water that is very hard has no known adverse health effects and probably may be more palatable than soft water. On the contrary, hard water forms scum and curd, causes yellowing of fabrics, toughens vegetables cooked in the water and forms scales in boilers, water heaters, pipes and cooking utensils.

**Calcium (Ca):** The concentration of Calcium (ca) in the well water samples ranges from 251.6-488.8mg/l, this indicates that all the water samples are not within the acceptable limit of WHO (2006) desirable limit of 75-200mg/l. A high concentration of calcium in water leads to water hardness but hard water has no known adverse health effects and probably may be more palatable than soft water.

**Chlorine:** The value of chlorine in the water samples from the wells has a value ranging from 58.9-82.6mg/l which is lower than the acceptable WHO (2006) standard value of 200mg/l.

**Sulphate (SO<sub>4</sub>):** Sulphate value in the water samples have a value range of 805.6-933.1mg/l and this exceeds the desirable WHO standard value of 200-400mg/l.

**Manganese (Mn):** The value of manganese contained in the water sample range from 0.139-0.296mg/l and this is within the desirable limit of WHO standard value of 0.05-0.5mg/l. Manganese is a mineral that naturally occurs in rocks and soil and may also be present due to underground pollution sources. Manganese is seldom found alone in a water supply. It is frequently found in iron-bearing waters but is more rare than iron. High exposure to manganese has been associated with toxicity to the nervous system, producing a syndrome that resembles Parkinsonism. Manganese is unlikely to produce other types of toxicity such as cancer or reproductive damage. standard. Iron in water has many negative effects, it is classified as a secondary contaminant, it often transmits bacteria that feed on the iron to survive.

**Lead (Pb):** The value of lead contained in the water samples ranges from 0.001-0.005mg/l compared with the acceptable value of 0.05mg/l of WHO standard. This element value falls within the acceptable WHO standard.

**Copper (Cu):** Copper concentration in the water samples ranges from 0.046-0.110mg/l, compared with the WHO standard value of 0.05-1.5mg/l. The water falls within the acceptable WHO standard value. Copper is a reddish metal that occurs naturally in rock, soil, water, sediment, and air. It is an essential element for living organisms, however, too much copper can cause adverse health effects, including vomiting, diarrhea, stomach cramps, and nausea. It has also been associated with liver damage and kidney disease.

**Iron (Fe):** Iron content in the water samples have a value of 0.152-0.400mg/l compared to the WHO standard value of 0.1-0.3mg/l. This indicates that well 3 (stream) and well 6 exceeds the acceptable.

**Chromium (Cr):** Chromium content in the water samples under study varies from 0.007 to 0.035mg/l compared to the WHO standard value of 0.02mg/l. The stream water Cr concentration 0.035mg/l, this exceeds WHO (2006) standard for consumption. Chromium an odorless, tasteless metallic element is found naturally in rocks, plants, soil and volcanic dust, and animals. The most common in natural waters are

trivalent chromium (chromium-3) and hexavalent chromium (chromium-6). Its effect on human being is devastating.

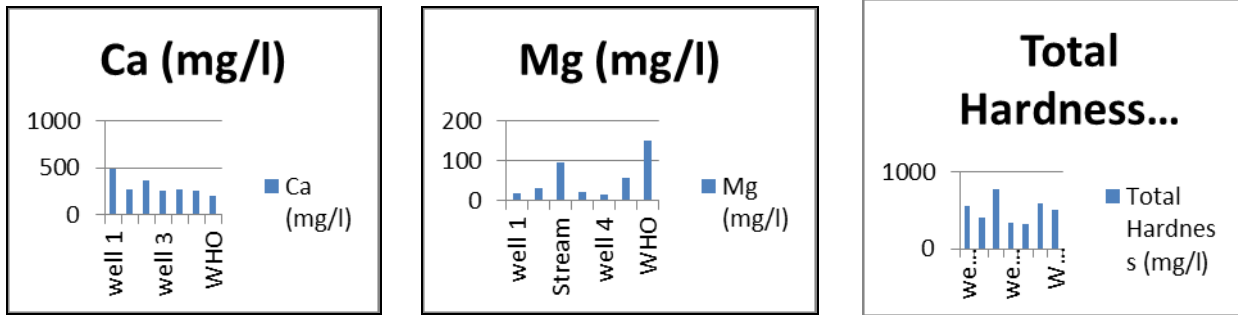


Fig. 5. Graph Showing Calcium content, Magnesium content, and Total hardness of the Water Samples

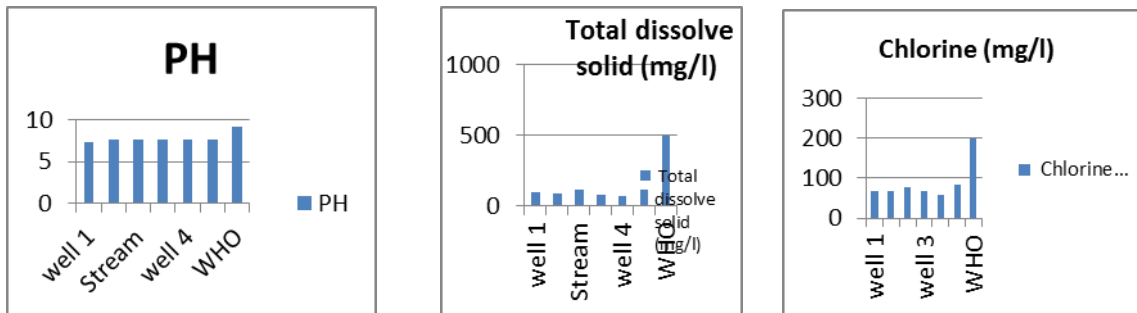


Fig. 6. P<sup>H</sup> Value of the Water Samples, Total Dissolved Solid content and Chlorine content

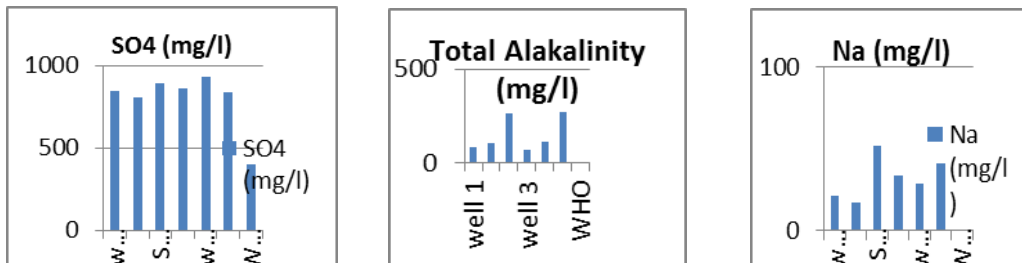


Fig. 7. Graph Showing Sulphate content, total Alkalinity content and Sodium content

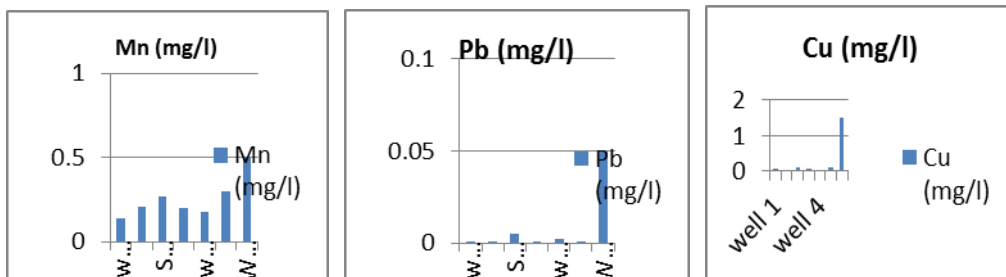


Fig. 8. Graph Showing Manganese content, Lead content and Copper content

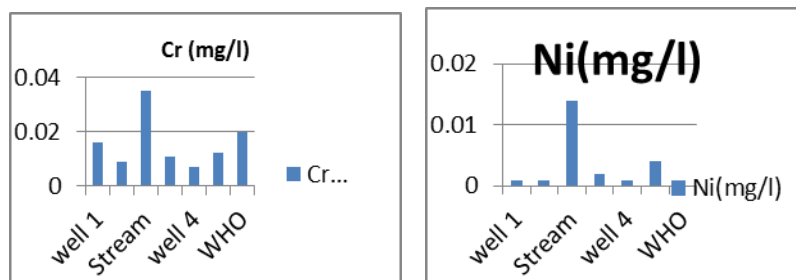


Fig. 9. Graph Showing Chromium content and Nickel content

**Nickel (Ni):** The concentration of nickel in the water samples ranges from 0.001-0.014mg/l, Nickel is necessary in many organism's diets but can become carcinogenic and toxic in high doses. Women are more commonly allergic to nickel exposure than men. Exposure to skin can cause dermatitis upon contact. When ingested through water, in small amounts, it is harmless to humans and in fact necessary in our diet

#### V. CONCLUSIONS AND RECOMMENDATION

Electrical resistivity (VES) and geochemical methods were used to evaluate the extent of contamination (pollution) of groundwater caused by dumpsite in the study area and has served as a measurement tool or approach to establish the depth of landfill occasioned by dumpsite activities using electrical resistivity, a predictive measure via resistivity values obtain from electrical resistivity, the presence of some trace metals such as; Ni, Cu, Na, Cr, Pb, Mn etc PH, hardness of the groundwater within the study area as well as comparism of results obtained from the Geochemical analyses with the International Standard (WHO) in order to ascertain the suitability of the water for drinking, domestic, laboratory and other public uses.

From this study, it is however concluded that leachate from the dumpsite in the study area has not adversely influenced the quality of the underlying groundwater, the results of geochemical analyses obtained indicated that most of the physical and chemical parameters fall within the acceptable value of the WHO (2006) standard. It is also established that geo-electrical investigation can be integrated with various geochemical analysis as a predictive measure to determine the quality of the subsurface water as lithology influence the constituents or ions present in the water. For example, low values of the Total Dissolved Solids (TDS) of the water samples dependent on the type of formation or rock types which the groundwater had contact with. The quality of the water determined by the high values of EC, Low TDS, high pH, high Hardness correspond to low resistivity values, high clay content and ion movement in the deep-seated fracture.

It is hereby recommended that feasibility studies be carried out prior to siting or developing groundwater in any area in order to ascertain depths to aquifers and by extension groundwater contamination potentials of the area. Every borehole water should pass through various physiochemical tests to know the portability and usage standards as speculated by World Health Organization (WHO, 2006). Dumpsites should not be sited within the proximity of underground water sources. Physiochemical analysis in future should be integrated with Microbial (Bacteriological) tests for detailed study.

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