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# DETERMINATION OF HEAVY METALS IN DUMP SITE USING RESISTIVITY METHOD IN UGBOR ROAD, BENIN CITY, NIGERIA

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## ABSTRACT
Surface geo-electrical survey using vertical electrical sounding (VES) method was carried out around dumpsite area in Ugbor, Benin City in Edo state, in order to determine the heavy metal concentration of groundwater in the area. Two Vertical Electrical Soundings were carried out within the area of study using Schlumberger array configuration, horizontally and vertically. The interpretation of the vertical electrical sounding (VES) data revealed three to six geo-electric layers with depth to the aquiferous layers ranging from 1m to 63m and resistivity of the saturated layers varied between 1026Ωm and 44636Ωm. From the interpretation, the most resistive layer in VES 1 is between layer 5 and 6 and, the most resistive layer in VES 2 is between layer 4 and layer 5. It also shows that the sediments of the various layers (1, 2, 3, 4, 5, and 6) of the study area have essentially laterite soil (top soil), poorly sorted sand, white clay, coarse sand moderately sorted and coarse moderately sorted whitish sand. It can be deduced that the depth of groundwater in the study area can be at the range of 57m and above in comparison with the lithology obtained. The laboratory result only indicates the presence of Iron as a heavy metal after comparing the result with the WHO standard result.

**Keywords:** Heavy Metals, Pollution, Resistivity method, Benin City, Nigeria

## INTRODUCTION
Ground water is the water found underground in the creeks and spaces in soil, sand and rocks. It moves slowly through layers of soil, sand and rocks called aquifers. These aquifers are permeable geologic unit that can transmit and store significant quantities of water. It is an important and major source of drinking water in both urban and rural areas in Nigeria. It can be used for drinking, cooking, paper industries, brewery companies, agricultural purpose, food processing and laundry and most importantly it is used to hydrate our bodies. Over 1.5 billion people worldwide depend on groundwater for drinking (Aondover, 2007).

Determination of quality water is one of the most important aspects in ground water studies. People around the world have used ground water as a source of drinking water and even today more than half of the world's population depends on groundwater for survival. It is the part of the precipitation that seeps down through the soil until it reaches rock material that is saturated with water (Bacud *et al*., 1994). The availability of groundwater resources have always been the primary concern of societies in semi-arid and arid regions, even in areas of more abundant rainfall. The problem of obtaining an adequate supply of quality water is generally becoming more acute due to ever increasing population and industrialization.

Heavy metals are group of metals and metalloids which have densities >5g/cm³ and exhibit atomic number >64. They are in most cases associated with pollution and toxicity of water and soil (Alloway and Ayres, 1997).

Heavy metals, such as copper, lead, mercury, and selenium, get into water from many sources, including industries, automobile exhaust, mines, and even natural soil and rocks.

Heavy metals enter the environment by natural and anthropogenic means. Such sources include: natural weathering of the earth crust, mining, soil erosion, industrial discharge, urban runoff, sewage effluents and pest or disease control agents etc.

Dumpsite is an old traditional method of waste disposal similar to landfill method of waste management. The dumpsite in ugbor, has been circled with buildings which is not ideal. As a result, when carrying out subsurface investigation with the instruments, there was not enough space to lay cables, only two VES points were taken. For safety reasons, they are often located far from human settlements. In most cases, especially in developing countries, disposal sites are not always properly planned; if planned at all. As the population of Benin City continues to rise (now estimated to be about 1.2 million; figure projected from 2006 population figures, human activities including soil fertility remediation, indiscriminate refuse and waste disposal, and the use of septic tanks, soak-away pits and pit latrines are on the increase. These activities are capable of producing leachates into the groundwater formation that serve as source of water to the inhabitants in the City. Furthermore, acidification and nitrification of groundwater have been linked to dumpsite around their outlets while a number of dumpsites have been implicated for bacterial contamination of drinking water, in some cases, causing poisoning, cancer, heart diseases and teratogenic abnormalities (Sia Su, 2008).

Previous studies have shown possible contamination of groundwater in the City. In 1992, Imeokparia and Offor observed the high level of iron (Fe), lead (Pb), nickel (Ni), manganese (Mn), and copper (Cu) in Ogba and Ikpoba Rivers in Benin City. High level of Fe has also been reported to be present in some borehole waters in the City. Momodu and Anyakora (2010) assessed groundwater contamination with heavy metals (Pb, and Cd) and Aluminum in Nigeria, and results showed that there is a significant risk for the population from drinking groundwater as these metals were detected in 98% of water samples analyzed in that study.

A study by Wogu and Okaka (2011) on Warri river water in the Delta region of Nigeria, recorded a Cd mean level of 0.0072 mg/l in the water and a range of 0.0 to 0.04 mg/l of Cd the water. The maximum value of Cd that was detected in the, water was above the maximum permissible level of Cd in drinking water.A similar study carried out by Singh and Chandel (2010) on heavy metals of industrial effluents at Jaipur, Rejasthan in India, Cd was undetected in all the samples that were tested. A study by Kisamo (2003) on the environment hazards associated with heavy metals in Lake Victoria Basin reported levels of Cd in soils ranging from 0.16 mg/l to 0.55 mg/l. The range recorded in the study was below the WHO maximum permissible limit of Cd set at 3 mg/l.

Mebrahtu and Zerabruk (2011) in their study of concentration of heavy metals in drinking water from urban areas of the Tigray Region, Northern Ethiopia using atomic absorption spectroscopy method of analysis detected levels of Pb of 1.347 mg/l at Indasilase and a minimum of below detection limit in drinking water samples from Alamata, Korem, Hagereselam, Zelambessa, Firewoini, Axum, Adwa and Enticho. More than 70.15 % of the water samples analyzed contained lead concentration within the WHO (2008) maximum allowable limit of lead in drinking water. In another study by Mebrahtu and Zerabrukin the Tigray region of Ethiopia on heavy metals in drinking water, chromium was detected in 12 out of 16 of the sampling areas. The mean levels of chromium detected in the 12 sampling areas ranged from 97µg/l to 146µg/l. The mean range was much higher than the WHO maximum admissible limit of chromium in drinking water of 50 µg/l. Of all the analyzed samples, 64.18% contained chromium above the WHO maximum admissible limit with the highest level of chromium recorded in water samples from Makelle (mean concentration, 146µg/l).

A study by Adeleken and Abegunde (2011) on the levels of heavy metals contamination at automobile mechanic villages in Ibadan, Nigeria reported levels of chromium in soil ranging from 2.0 to 29.75 mg/l.

Raji *et al.* (2010) recorded the following levels of manganese in drinking water in Sokoto, Nigeria; station T1 0.670 mg/l, station T2 0.800 mg/l, station T3 0.550mg/l, station WB(R) 0.550 mg/l and WB (T) 0.510 mg/l.

## STUDY AREA

This work was carried out at Ugbor, Benin city using vertical electrical sounding method to determine the presence of heavy metals. The study was carried out in dumpsites within the environs of Benin City, Edo state, southern region of Nigeria. The area of investigation lies within latitude 6° 23.055′ N to 6° 27.339′ N and longitude 5° 36.0018′ E to 5° 44.130′ E approximately 350km SW of Abuja.

Geologically, the study area lies within the Benin Formation which extends from the west across the whole of the Niger Delta area and southward beyond the present coastline. It consists of over 90% sandstone with shale intercalations. It is coarse grained, gravelly, locally fine grained, poorly sorted, sub-angular to well- rounded and bears lignite streaks and wood fragment. It is a continental deposit of probably upper deltaic depositional environment.

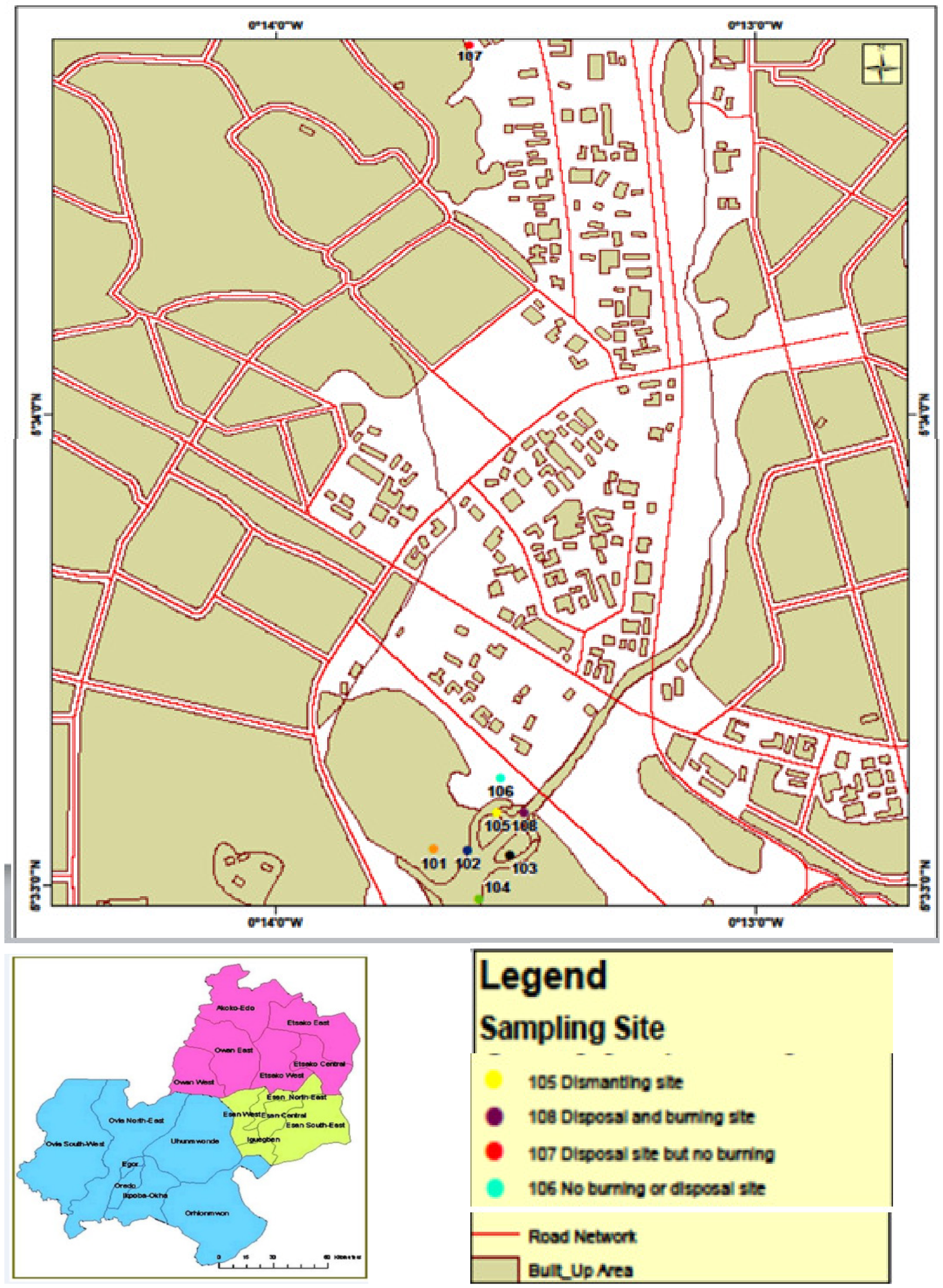



Figure 1: Geological Map of Edo State showing Benin City and other locations. (Nigerian Geological Survey Agency, 2006)

**SURVEY TECHNIQUE**

The data in tables 1.1 and 1.2 below were collected using Vertical Electrical Sounding VES (resistivity method) method at ugbor road using schlumberger array method for the electrode configuration. Different Vertical Electrical Soundings were acquired at different locations within the study area with maximum spread of

200metres with an SAS 300C ABEM Terrameter and its accessories. Only one dimension was looked into.

In this method, the center point of electrode array remains fixed, but the spacing between the electrodes is increased to obtain more information about the deeper sections of the subsurface. The measured apparent resistivity values are normally plotted on a log graph paper.

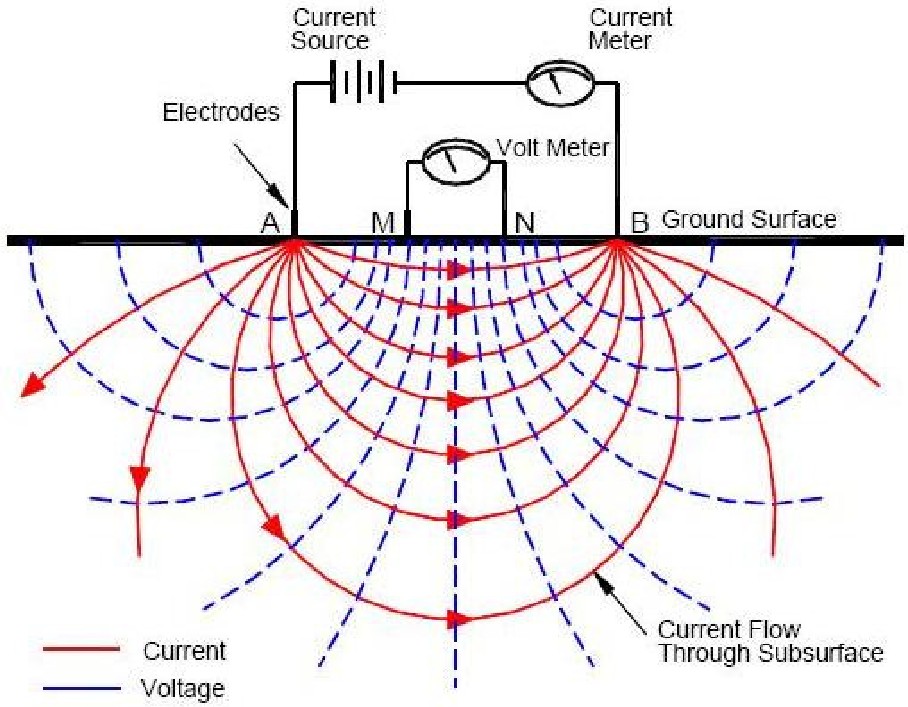



Figure 2: Schlumberger Electrode Configuration. (Ward, 1990)

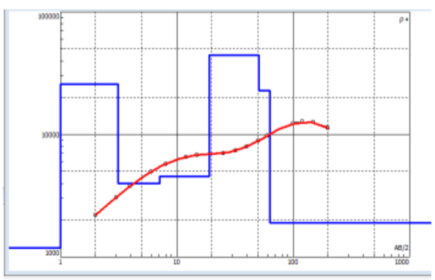
## RESULT AND DISCUSSION

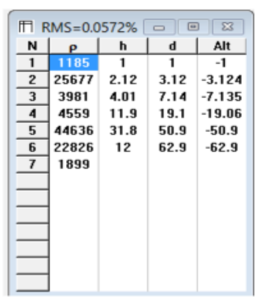
In resistivity method, there are two types of interpretation of data; we have the curve matching and the computer iteration. The interpretation for this work was done using an iteration method (1p2win software), the resistivity values of the geoelectric units, the thicknesses, and correlation of lithologic logs from bore holes within the area were used in conjunction with the regional geology of the study area. To interpret the data from such a survey, it is normally assumed that the subsurface consists of horizontal layers. In this case, the subsurface resistivity changes only with depth, but does not change in the horizontal direction. Another classical survey technique is the profiling method. In this case, the spacing between the electrodes remains fixed, but the entire array is moved along a straight line. This gives some information about lateral changes in the subsurface resistivity but it cannot detect vertical changes in the resistivity. The field data curves obtained as a result of plotting the apparent resistivity values against electrode, spacing was done using the computer iteration method. This method automatically shows the values of each layer.

***Resistivity Field Record***

Table 1: UGBOR VES1

| AB/2 | MN | RESISTANCE(Ω) | G. FACTOR | RESISTIVITY(Ωm) |
|---|---|---|---|---|
| 2 | 0.8 | 134 | 15.08 | 2020.72 |
| 3 | 0.8 | 109 | 34.715 | 3783.935 |
| 4 | 0.8 | 074 | 62.204 | 4354.28 |
| 6 | 2.0 | 77.5 | 54.978 | 4260.795 |
| 8 | 2.0 | 669 | 98.96 | 66204.24 |
| 12 | 2.0 | 353 | 224.62 | 79290.86 |
| 15 | 4.0 | 247 | 113.1 | 27935.7 |
| 25 | 4.0 | 117 | 322.54 | 37737.18 |
| 32 | 4.0 | 059 | 531.45 | 31355.55 |
| 40 | 10 | 90 | 494.8 | 44532 |
| 50 | 10 | 085 | 777.54 | 66090.9 |
| 60 | 10 | 400 | 1123 | 449200 |
| 100 | 20 | 420 | 3134 | 1316280 |
| 120 | 20 | 703 | 4516 | 3174748 |
| 150 | 20 | 102 | | |
| 200 | 20 | 223 | | |

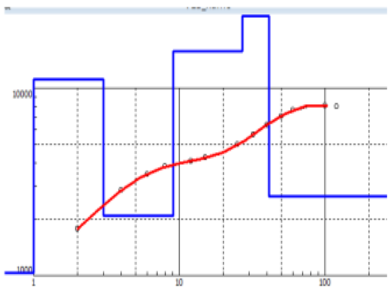




RMS=0.0572%

| N | ρ | h | d | Alt |
|---|---|---|---|---|
| 1 | 1185 | 1 | 1 | -1 |
| 2 | 25677 | 2.12 | 3.12 | -3.124 |
| 3 | 3981 | 4.01 | 7.14 | -7.135 |
| 4 | 4559 | 11.9 | 19.1 | -19.06 |
| 5 | 44636 | 31.8 | 50.9 | -50.9 |
| 6 | 22826 | 12 | 62.9 | -62.9 |
| 7 | 1899 | | | |

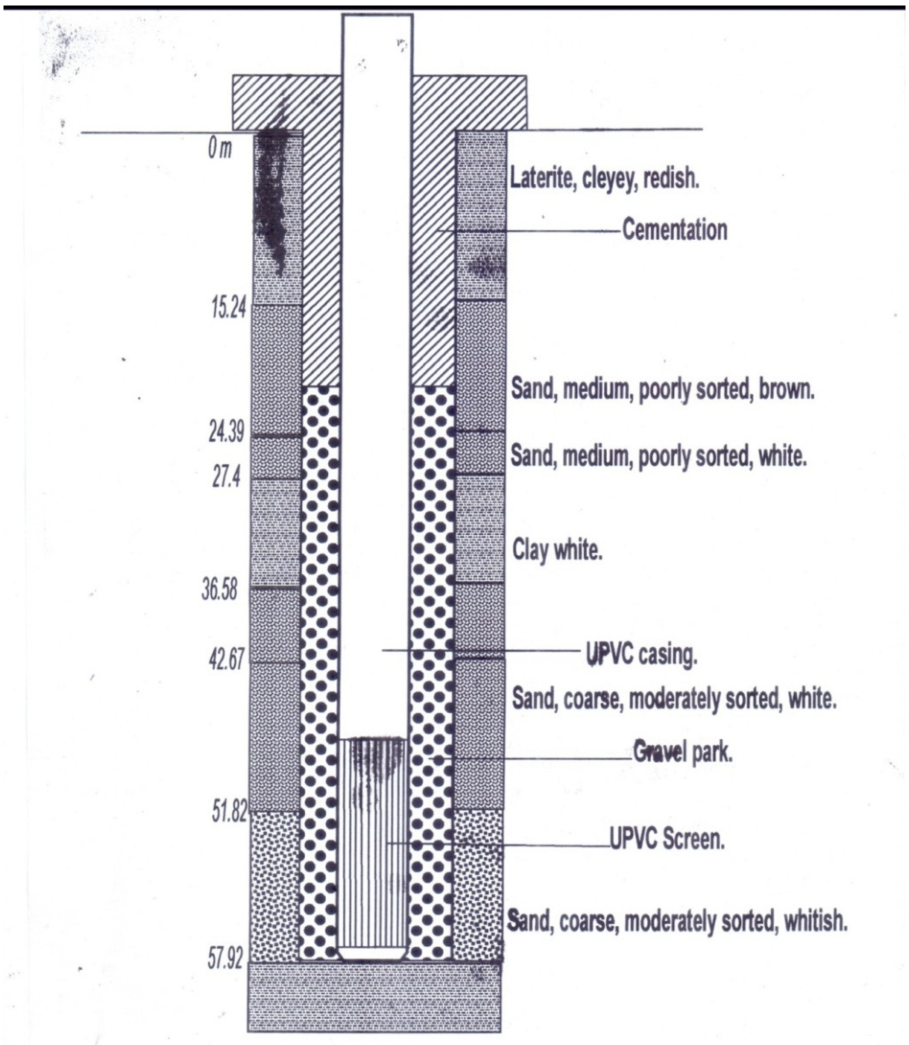
TABLE 2: UGBOR VES 2

| AB/2 | MN | RESISITANCE (Ω) | G FACTOR | RESISTIVITY (Ωm) |
|---|---|---|---|---|
| 2 | 0.8 | 050 | 15.08 | 754 |
| 4 | 0.8 | 011 | 62.204 | 684.244 |
| 6 | 2.0 | 80.5 | 54.9784rf | 4425.729 |
| 8 | 2.0 | 071 | 98.96 | 7026.16 |
| 12 | 2.0 | 042 | 224.62 | 9434.04 |
| 15 | 6.0 | 057 | 113.1 | 6446.7 |
| 25 | 6.0 | 048 | 322.54 | 15481.92 |
| 32 | 6.0 | 043 | 531.45 | 22852.35 |
| 40 | 10 | 39.5 | 494.8 | 195446 |
| 50 | 10 | 035 | 777.54 | 27213.9 |
| 60 | 10 | 168 | 1123 | 188664 |
| 100 | 20 | 038 | 3134 | 119092 |



RMS=0.211%

| N | ρ | h | d | Alt |
|---|---|---|---|---|
| 1 | 1028 | 1 | 1 | -1 |
| 2 | 11084 | 2.01 | 3.01 | -3.006 |
| 3 | 2081 | 6.03 | 9.03 | -9.034 |
| 4 | 15824 | 18.1 | 27.2 | -27.15 |
| 5 | 25200 | 14.1 | 41.3 | -41.29 |
| 6 | 2637 | | | |




Ugbor Borehole lithologic section and well design

Two VES points were taken at the study area and were very close to the dumpsite. The maximum current electrode spacing (AB/2) used are 200 and 100m respectively. Each VES point generated six geo-electric layers. In the first layer, the resistivity value ranges from1185Ωm in Ves 1 and 1028 Ωm in Ves 2, with depths of 1m in each Ves .This is the topsoil (laterite soil).

The second layer has resistivity value of 25677 Ωm in Ves 1 and 11084 Ωm in Ves 2 which showed sand, medium, poorly sorted, with relative depths of 3.1m and 3.01m in VES 1 and VES 2

The third layer has resistivity value of 3981 Ωm in Ves 1 and 2081 Ωm in Ves 2, which showed sand, medium, poorly sorted white with relative depths of 7.14m in Ves 1 and 9.03m in Ves 2.

The fourth layer has resistivity value of 4559 Ωm in Ves 1 and 15824 Ωm in Ves 2, which showed clay white with relative depth of 19m in Ves 1 and 27m in Ves 2.

The fifth layer has resistivity value of 44636 Ωm in Ves 1 and 25200 Ωm in Ves 2, which showed coarse sand moderately sorted, white with relative depths of 50.9m in Ves 1 and 41.3m in Ves 2.

The sixth layer has resistivity value of 22826 Ωm in Ves 1 and 25200 Ωm in Ves 2, which showed sand coarse moderately sorted whitish with relative depth of 62.9m in Ves 1 and infinite depth in Ves 2.

From the interpretation above, VES 1 is a five layered curve with increasing value which shows a HAA-type of curve. VES 2 is a four layered curve with an increasing value which shows a HA- type of curve. From the water analysis, it showed that the water in Ugbor has a pH of 7 which is within the WHO standard that ranges from 7-8.5. It has a colour of 5 which is also within the WHO standard that ranges from 3-15. The total dissolved solid is 12 which is above the WHO standard.

From this project, It was observed that the conductivity in the area of study was high, which signifies low resistivity and it shows that the contaminant and leachate are high. The vertical electrical sounding (VES) has provided valuable information on the nature of the subsurface layers. The water analysis also indicates the presence of Iron as a heavy metal.

## CONCLUSION

From the study, the water analysis carried out, showed the presence of Iron. According to the WHO standard, the heavy metal found is below the standard, therefore making the water in this dumpsite area unfit for consumption unless treated. Also for further investigation to determine the movement of the leachate and heavy metals, a wenner array electrode arrangement is advised and also involving two dimension.

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