

Trace Sulphate and Nitrate Analysis in Soil and Water Samples around Selected Flow Stations in Delta State, Nigeria

Onwukeme, V.I.¹; *Etienajirhevwe, O.F.²

¹Department of Pure and Industrial Chemistry, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

²Department of Science Laboratory Technology, Delta State Polytechnic, Otefe, Oghara, Nigeria

Email address: ¹valentineifenna @ yahoo.com

Abstract— This research work covers the comparative determination of sulphate and Nitrate in soil and water around some selected flow stations in Delta State, Nigeria. Soil and water samples were collected in triplicate for a period of three months and were analysed for the presence of sulphate and nitrate using Uv/Visible Spectrophotometer. Results of water analysis showed mean sulphate to be 0.63 ± 0.12 , 0.92 ± 0.29 , 2.68 ± 0.14 and 0.37 ± 0.05 mg/L while sulphate was 0.71 ± 0.31 , 0.39 ± 0.05 , 0.12 ± 0.02 and 0.18 ± 0.03 mg/L for Platform Petroleum (PPL), Warri Refinery (WRPC), Amukpe Flow station (AFS) and Transcorp Power Station (TPS, which was the control site) respectively. Results of soil analysis showed mean sulphate to be 120.10 ± 47.25 , 362.67 ± 27.08 , 112.97 ± 15.37 and 99.02 ± 2.76 mg/kg while mean nitrate was 30.40 ± 11.02 , 127.58 ± 77.09 , 154.88 ± 4.84 and 12.56 ± 2.16 mg/kg for PPL, WRPC, AFS and TPS respectively. The soil was found to be more contaminated / polluted than the water and the results found some locations polluted while others were slightly contaminated and this therefore calls for measures to mitigation due to possible health implications.

Keywords— Concentration, pollution, contamination, water and soil.

I. INTRODUCTION

The atmosphere is the gaseous envelope that surrounds the earth and constitutes the transition between its surface and the vacuum of space^[1]. Concerns about the air quality have probably been around as long as mankind; from the moment fire was invented, air pollution became a problem^[2]. The pollution of the aquatic environment with organic and inorganic contaminants has become a world problem during recent years because they are indestructible and most of them have toxic effects on organism^[3]. Among environmental pollutants, metals are of particular concerns due to their potential toxic effects and ability to accumulate in aquatic ecosystem^[4]. Deposition of contaminants on soil may be deleterious to soil growth and soil productivity and may also produce crops containing unacceptably high level of contaminants for animal and human health; serious systematic health problems could develop as a result of excessive accumulation of dietary contaminants in the body^[5]. Breathing is not optional, it is essential even for a short time and air has to be used as it is found and “the air we receive at our birth and resign only when we die is the first necessity of our existence”^[2]

Analysis of water and soil shows the presence of numerous substances in trace amounts some of which could be explained to emanate from either natural or anthropogenic that is, man-made source activities; other substances could be formed indirectly from chemical process in the atmosphere. Hence, the combination of a source to the atmosphere varies according to its emission characteristics and the emitted substance^[6]

Despite the essential ingredients of water and soil, their qualities has been historically variable and frequently to the detriments of human health. Nevertheless, our quality of life dramatically improved during the twentieth century. Now however, a growing body of research has found that certain substances may affect human health at lower concentration than had previously been thought. This concern has heightened public anxiety to the importance of improving and managing the quality of air, soil and water is protected and managed for future generations^[7]

The aim and objectives of this work is to determine and compare the concentrations of sulphate and nitrate around some selected flow stations in Delta State, Nigeria.

II. MATERIALS AND METHODS

2.1 Sample Collections

2.1.1 Soil Sampling

Soil samples were collected at the (3) sampling locations and at the control site with the aid of a soil auger at depth 0-15cm and 15-30cm. The soils were put in black polythene bags labeled and were transported to the laboratory for chemical analysis. Three soil samplings were carried out at each location within the months of February, March and April 2017 and a total of eighteen (18) soil samples were collected for the three locations and six (06) from the control site making a total of twenty four (24) samples

2.1.2 Water Sampling

Water samples were collected at (3) sampling locations and at the control site with the aid of a water sampler. The water was collected in an acid washed and distilled water rinsed polypropylene bottles labeled and were transported to the laboratory for chemical analysis. Three water samplings were carried out for each location within the months of February, March and April 2017 and a total of nine (9)

samples were collected for the three locations and three (3) from the control site making a total of twelve (12) samples.

2.2 Analysis of Samples

2.2.1 Soil Analysis

2.2.1.1 Sulphate (SO₄²⁻) analysis

The soil samples collected from the various sites were dried at 60±5°C in an oven and were allowed to cool to 25±3°C in desiccators to constant weight, and were pulverized to pass through a 425µm sieve. 20g of the soils were measured and 400mL of distilled water was added and were vigorously shaken for 1 minute and were allowed to stay for 12 hours after which they were filtered into conical flasks through a funnel with filter paper and the filtrate was kept for the determination of sulphate.

10mL of the filtrates were measured with a graduated cylinder into a vial and one sulphate test tablet was added, capped and was shaken vigorously. The resulting solutions were then tested for sulphate by using UV/visible spectrophotometer at 608nm wavelength^[8]

2.2.1.2 Nitrate (NO₃²⁻) analysis

Soil samples from the study sites were dried at 60±5°C in an oven and were allowed to cool to 25±3°C in desiccators to constant weight and were pulverized to pass through a 425µm sieve. 20g of the soils were then measured followed by the addition of 400mL of distilled water and were vigorously shaken for 1 minute and were allowed to stand for 12 hours after which they were filtered into a conical flasks through a funnel and filter paper and the filtrate were kept for the determination of nitrate.

10mL of the filtrates were measured with a graduated cylinder into a vial and one nitrate test tablet was added, capped and were shaken vigorously. These resulting solutions were tested for nitrate by using UV/visible spectrophotometer at 550nm wavelength^[8]

2.2.2 Water Analysis

2.2.2.1 Sulphate (SO₄²⁻) analysis

10mL each of the samples was added with 1mL of 6M HCL followed by 5mL of 70% sorbitol and were properly mixed and sulphate were noted at 470nm wavelength on a spectrophotometer. Standards were prepared with the same procedure and SO₄²⁻ were determined accordingly^[9]

2.2.2.2 Nitrate (NO₃²⁻) analysis

25mL each of the samples was measured into a cylinder followed by the addition of a “Nitrover 6” pillow reagent powder so as to ensure NO₃²⁻ development and were homogenized and subsequently analyzed with a UV/visible spectrophotometer at wavelength of 550nm^[8]

2.3 Statistical Analysis

Data obtained from the experiments were checked by using Minitab statistical package. Descriptive statistical analysis was used to check the means and standard deviations of the collected date. Inter – station comparisons were carried out to check the differences between the locations using parametric analysis of variance (ANOVA). Dunnette multiple comparison tests were further carried out to determine the

location of significant differences compared with the control site.

III. RESULTS

TABLE 1: Sulphate concentration in surface water

LOCATION	FEB.	MAR.	APR.	MEAN±SD
TRANSCORP POWER (Control)	0.43	0.33	0.36	0.37±0.05
PLATFORM PETROLEUM	0.51	0.65	0.74	0.63±0.12
WARRI REFINERY	0.67	0.84	1.24	0.92±0.29
AMUKPE F/STATION	2.64	2.57	2.84	2.68±0.14

TABLE 2: Sulphate concentration (mg/kg) in Soil

LOCATION	FEB.	MAR.	APR.	MEAN±SD
TRANSCORP POWER (Control)	97.12	102.20	97.38	99.03±2.76
PLATFORM PETROLEUM	88.42	97.47	174.40	120.10±47.25
WARRI REFINERY	365.00	388.50	334.50	362.67±27.08
AMUKPE F/STATION	101.04	107.56	130.32	112.97±15.37

TABLE 3: Nitrate Concentration (mg/L) in Surface Water

LOCATION	FEB.	MAR.	APR.	MEAN±SD
TRANSCORP POWER (Control)	0.16	0.18	0.21	0.18±0.03
PLATFORM PETROLEUM	0.87	0.91	0.35	0.71±0.31
WARRI REFINERY	0.32	0.38	0.46	0.39±0.05
AMUKPE F/STATION	0.12	0.14	0.11	0.12±0.02

TABLE 4: Nitrate Concentration (mg/kg) in soil

LOCATION	FEB.	MAR.	APR.	MEAN±SD
TRANSCORP POWER (Control)	10.21	13.01	14.46	12.56±2.16
PLATFORM PETROLEUM	33.44	39.58	18.17	30.40±11.02
WARRI REFINERY	70.19	97.34	215.21	127.58±77.09
AMUKPE F/STATION	194.50	159.00	111.13	154.88±41.84

IV. DISCUSSION

Results of sulphate in water and sulphate in soil are shown in tables 1 and 2 respectively. Sulphate was found present at all the locations with an increase across the months and was found to be higher than the control site (Trannscorp power station). Among the locations, Amukpe flow station recorded the highest mean sulphate concentration (2.6mg/L) while Platform petroleum was the least (0.63mg/L). All the locations were found to be within permissible value of the World Health Organisation (WHO) which is 250mg/L hence the water are safe for domestic purpose. Statistical analysis of the means and standard deviations showed equal contamination at the various locations while Dunnette Multiple comparison of each location with the control site showed that Warri refinery and Amukpe flow station were significantly different that is, they are polluted with sulphate when compared with the control site. The difference suggested contamination which could be attributed to: the rate of glass flaring by which sulphur dioxide is being released into the atmosphere, form acid rain and find itself into water body; the discharge of effluent into the water body by company at the study locations which would also increase the concentration of sulphate in water.

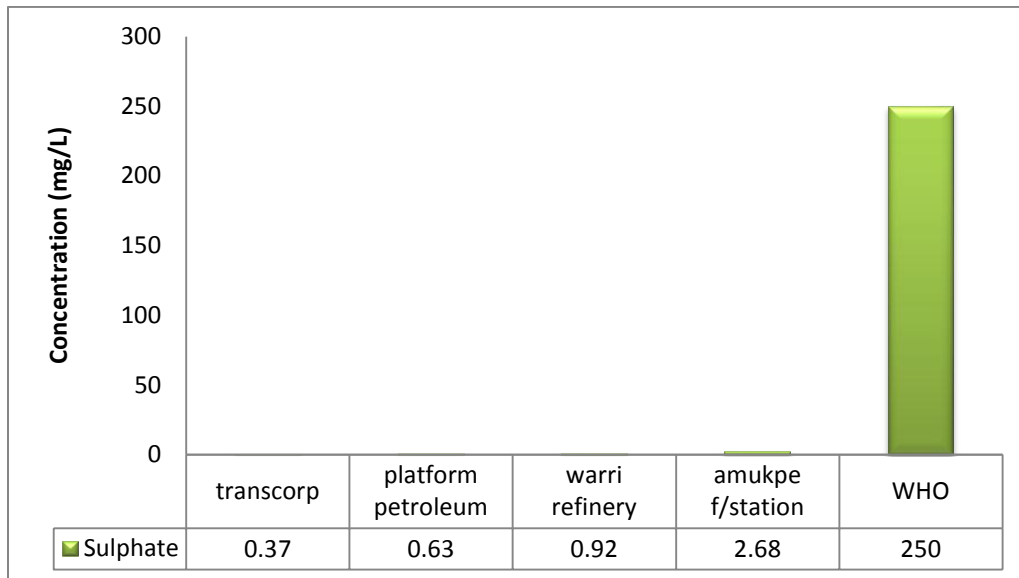


Fig. 1: Sulphate concentration in water compared with WHO

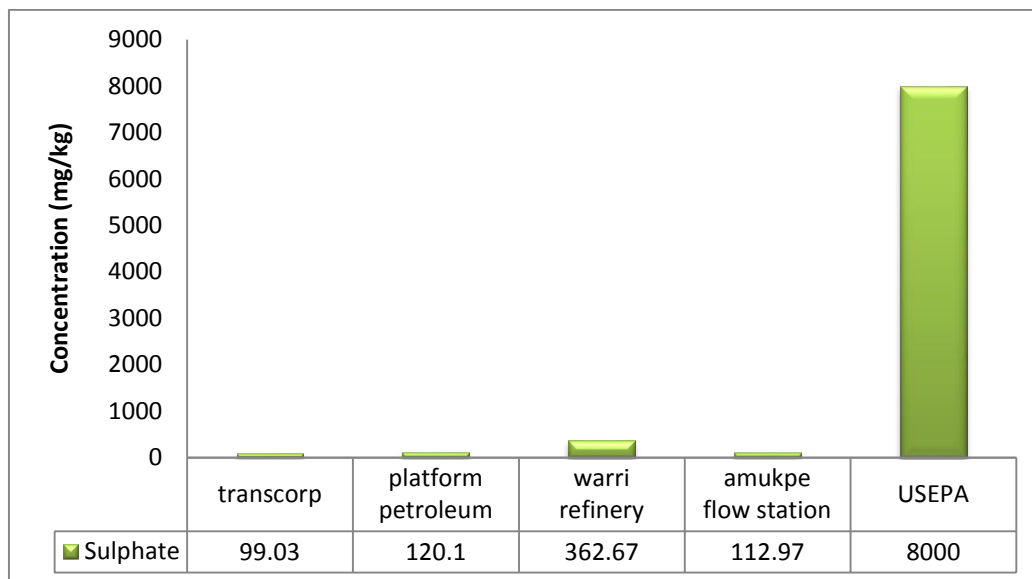


Fig. 2: Sulphate concentration in soil compared with USEPA

Sulphate concentration in soil was found to increase across the months with Warri refinery and Amukpe flow station higher than the control site (Transcorp Power Station). Platform petroleum was lower than the control site in the months of February and March but was higher in the month of April. Warri refinery recorded an extreme value of 362.67mg/kg compared to other locations and the control site with 120.10, 112.97 and 99.03mg/kg respectively. All the study locations were found to be contaminated when compared with United State Environmental Protection Agency (USEPA) permissible value of 8000mg/kg for uncontaminated soil. Statistical analysis of the means in comparison with the control site suggested pollution as sulphate concentrations were significantly different from the control site. The presence of sulphate in soil could be attributed to the release of sulphur dioxide in air which reacts with water to form acid rain and

later falls to the ground (soil) in soluble form and when these acids sulphate soils are disturbed, they can generate large amount of sulphuric acid and sometimes heavy metals which cause major impact to the environment and to infrastructure. Construction projects in acid sulphate soils area can be difficult to manage even when soil is not acidified^[10]. As many acid sulphate soils are unconsolidated, estuarine muds and clays with gel-like properties and low load bearing capacity, foundation built on these materials may settle or subside unevenly and slowly. Careful engineering is required to avoid problems with subsidence, which can cause roadways to slump and foundation to crack^[10]

The concentration of sulphate in water and soil in the study locations including the control followed the same trend across the months. The soil was highly polluted while water was the least. Since the water is not stagnant and always flows

upstream and downstream, the contamination tends to be reducing over time while the soil would retain the acid sulphate rain on its surface and may also seeps to the ground and be retained.

Results of nitrate in water and nitrate in soil are shown in tables 3 and 4 respectively. Nitrates concentration in water were found to be increasing from the month of February through April at Warri refinery and the control site (Transcorp power station) with little difference at Amukpe flow station and Platform petroleum where there was a decrease in the

month of April. Among the locations, Platform petroleum recorded the highest concentration of nitrate (0.71mg/L) followed by Warri refinery while Amukpe flow station was the least. The concentration of nitrate at Platform petroleum and Warri refinery were higher than that of the control while Amukpe flow station was lower. The concentration of nitrate in all the locations were within the permissible value of WHO which is 45mg/L which showed that all the water analyzed are fit for domestic use.

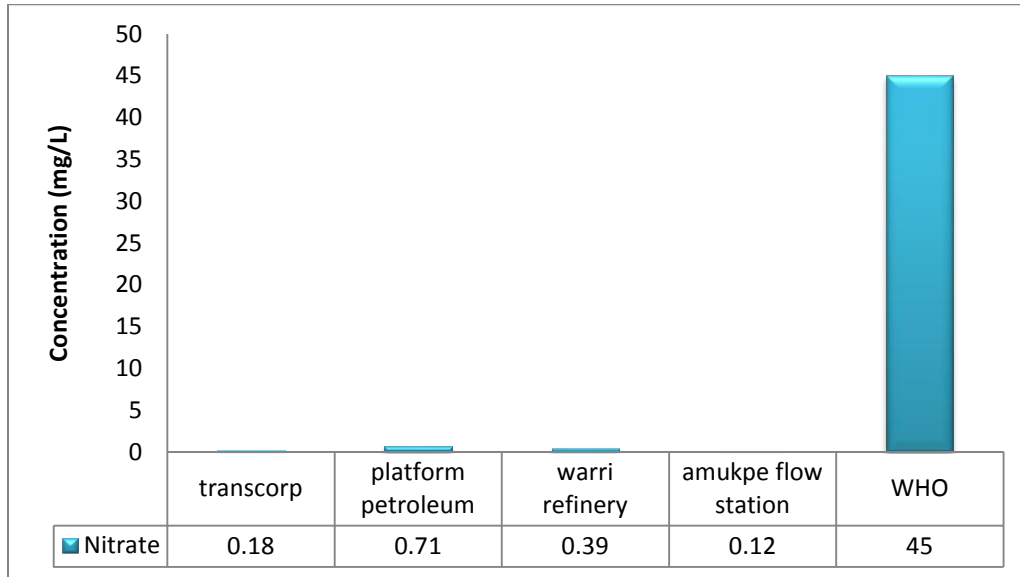


Fig. 3: Nitrate concentration in water compared with WHO

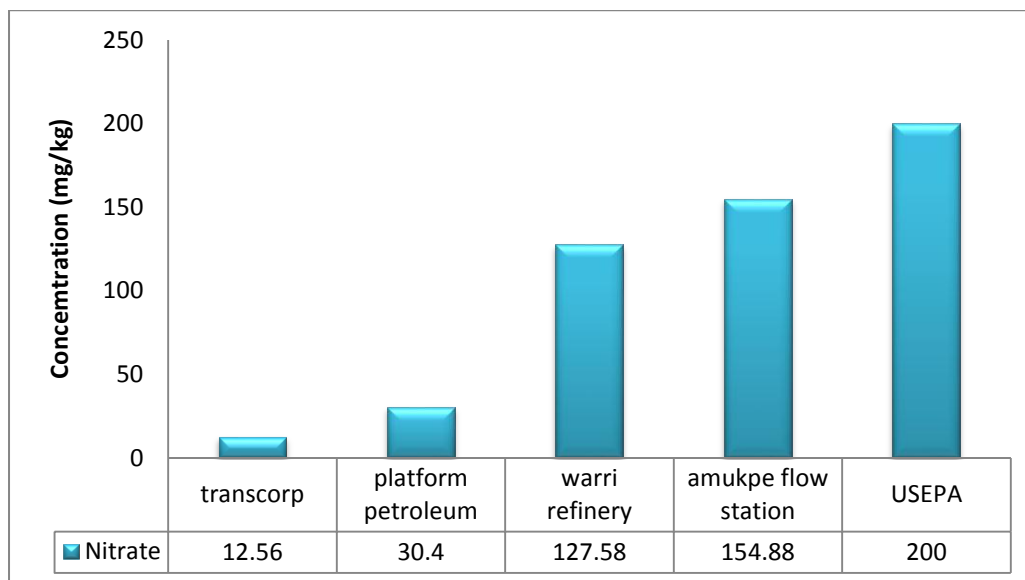


Fig. 4: Nitrate concentration in soil compared with USEPA

Statistical analysis of the results suggested contamination at Platform petroleum since the results at this location was significantly different from that of the control site which could be attributed to the run – off of nitrogen fertilizer from nearby farm land, discharge of effluents in water and soluble nitrate

from atmosphere though rain fall^[11]. It is worth noting that when the level of Nitrate exceeds the permissible limit then the primary health hazard of consuming such water may occur when nitrate is transformed to nitrite in the digestive system

which oxidizes iron in the hemoglobin and causes blue baby syndrome^[12]

Nitrate concentration in soil was found to increase across the months at Platform petroleum, Warri refinery and at the control site (Transcorp power station) while decrease was observed at Amukpe flow station. Amukpe flow station recorded the highest nitrate concentration of 154.88mg/kg while Platform petroleum recorded the lowest value of 30.40mg/kg. The results of nitrates at all the locations were found to be in conformity when compared with USEPA permissible value of 8000mg/kg for uncontaminated soil though high contamination was observed as all the nitrate were higher than that of the control with nitrate value of 12.56mg/kg. Statistical analysis also suggested high contamination as nitrate concentrations at all the locations were significantly higher than the control. Though nitrate naturally occur in soil, commercial fertilizers and manure, excess application can contaminate the soil by leaching thereby becoming an environmental hazard and creating a potential health concern^[13]

The soil and water were all found to be contaminated with nitrate due to the rate of gas flaring in the locations which are washed down in soluble form into the soil during rain fall and seep into the soil and are further washed into water body by erosion. The concentration of nitrate in water was lower because its presence could be distributed and / or carried away from one point to another as the case may be.

V. CONCLUSION AND RECOMMENDATION

Among the study locations, Platform Petroleum and Warri Refinery were found to be the most polluted followed by Amukpe Flow Station compared to Transcorp Power Station which is the control site. The pollution of the locations followed the order: Platform Petroleum > Warri Refinery > Amukpe Flow Station > Transcorp Power Station (control site). Water was found to be more polluted than the soil. This is because water is the end location where all the contaminants would be deposited though the soil tend to retain the pollutants for a long time while the water tend to carry them from one point to another. It is therefore worthy to note that consumption of food polluted through soil and consumption of water polluted by these pollutants would pose serious health problems. Planting in soil and drinking of water is obligatory and without it there is no life. It is today's generations of people who have realized that the food they process from soil and the water they drink is not an unlimited natural resources. It should be a concern to effectively manage water and soil for a sustainable future. The management of these natural resources should enquire methods and techniques based on sound science and careful application towards finding solution to already polluted resources. There should be future development of water and soil pollution management by bringing awareness to the general public of the scale of these pollutions and how to manage them. There should be the development of philosophy and attitude towards monitoring these pollutions. As an individual, we must consider the consequences for our actions and work to improve air, water and soil quality for future generation. The management of air,

water and soil pollution problems cannot be over emphasized hence we must avoid the reoccurrence of these pollution problems we are facing today

ACKNOWLEDGEMENT

Staff of Delta State Polytechnic, Otefe, Oghara, Nigeria and Mr Bangboye Adeola of Lighthouse Petroleum Engineering Company, GRA, Effurun, Delta State, Nigeria are appreciated for the use of their laboratory facilities for chemical analysis.

REFERENCES

- [1] Bhatia SC. Environmental Pollution and control in chemical process industries, Khanna Publishers, 2009; p.163
- [2] Brimblecombe P. The Big Smoke, A history of air pollution in London since medieval times, Routledge, London. 1987
- [3] MacFarlane GR, Burchett MD. Cellular distribution of copper, lead and zinc in the grey mangrove, Avicennia Marina, Vierh, *J. Aquat Bot.* 2000; 68:45-59.
- [4] Censi P, Spoto SE, Sciano F, Spronvieri M, Mazzola S. Heavy metals in coastal water system, a case study from North Western Gulf of Thailand, *Chemosphere*, 2006; 64:1167-1176.
- [5] Ekeayanwu, RC, Ogbuniyi CA, Etienajirhevwe OF Trace metal distribution in fish tissues, bottom sediments and water from Okumeshi river in Delta State, Nigeria, *Environ Res J*, 2011; 5(1):6-10.
- [6] Imonitie IO, Ndego EC. Hydrochemical investigation of groundwater in Obiarukwu, Delta State, Nigeria. *Ethiopian Journal of Environmental Science And Management*, 2014; 6(2) 311-318.
- [7] Department of the Environment (DoE). Urban Air Quality in the United Kingdom, HMSO, London, 1993
- [8] HACH. The HACH Handbook for portable Spectrophotometer, DR 2400, Methods 8039, 8051 and 8331, 2002
- [9] Amjad AB, Mohammed ID, Parveez IP. Chemical Characteristics of Drinking Water of Reshawar, *Pakistan Journal of Nutrition*, 2010; 9(10):1017-1027.
- [10] Edino K. Construction equipment: Maintenance and their rescue. ASUP book of proceedings, ASUP, Otefe Oghara, Delta State, 2015; p.274.
- [11] Weinberg HS. Measuring quality, the development of methods to assess drinking water, *J. of Environ Sci and Engr.* 2006; 98:192-196
- [12] Yang CY, Chiu HF, Chang MF, Tsai SS, Hung CF, Lin MC. Cancer mortality and heavy metals levels in Taiwan's drinking water *J. Environ Res.* Section A, 1999; 81:302-308.
- [13] Adewole MB, Uchegbu LU. Properties of soils and plants uptake within the vicinity of selected Automobile Workshops in Ile-Ife Southwestern, Nigeria-*Ethiopian Journal of Environmental Science And Management*, 2010; 3(3) 31-38.

*Corresponding author:

etienajirhevwe.omonigho @ ogharapoly.edu.ng; Department of Science Laboratory Technology, Delta State Polytechnic, Otefe, Oghara, Nigeria