A Partial Environmental Engineering Management Study of Open Dump Site and Its Impact on Land and Water

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***Abstract* — This research appraises in partial the environmental engineering effects of open dumpsite with peripheral study of the dumpsite at km 3 Aba-Enugu Expressway in Abia State southeast of Nigeria. The investigation includes visual assessment, interviews / questionnaires results, and analysis. The study reveals that the waste dump serves as a sink to many parts of Aba metropolis being one of the biggest dumpsites in Abia state. The sand value of 47.7% obtained from the study agrees with existing literature/hydrogeology of the area. Results proved that the ground water is safe as samples display quality, which are below the Nigerian standards for drinking water quality limit. These values also fall below the World Health Organization (WHO) water quality limit so the residents around do not stand any health risk at the moment. However, increasing concentration of pollutants indicates that the Soil and probably the potential drinking water source may be contaminated with time, supporting existing study. Therefore, this research recommends a well-engineered waste management plan alongside Extended Producer Responsibility (EPR) cradle-to-grave approach to management of open dumpsite.**

***Index terms* — Resources management, safety, pollution and operational sustainability.**

I. Introduction

Solid wastes can be defined as non-liquid and non-gaseous products of human activities, regarded as being useless [1]. These useless or unwanted parts of a product vary in composition and could be useful when converted for needs outside its original design. Final waste destination from households that are not well structured, mostly uncovered and lacking effective environmental control methods are termed Open dumps sites.

Human activities generate waste. Therefore, it is not unlikely that with increase in population or increase in the number of people residing or doing business closely that waste will in turn increase. Earlier stage of human existence, when people are few experienced little or no attention to environmental engineering effects of waste generation because they could be burned or covered with earth safely. Conversely, as the density of people in urban area increased, so did activities, the end result is more waste generation with associated technological and commercial harmful effects to both land and water bodies. Man has been afterwards faced with the onerous task of putting measure in place and designing better waste management plan that will ensure minimal negative impact on resources and humans. Furthermore, engineering activities evolves with technological implications that do not spare waste creation, handling and disposal with its attendant pollution/public health challenges. Currently most urban cities are experiencing increased waste production and their management remains an issue of great concern to most town authorities. In a move to avert waste inconveniences, dumping sites, are mostly located at areas less populated by humans. Developing such areas in the near future requires huge engineering inputs due to accumulation effects and possible degradation of land and water resources.

Municipal wastes in Nigeria as with most developing nations contain wastes of different nature: metal scrapes, individual, commercial, degradable, and non-degradable thrash, some harmful to humans. The volume of research work on open dump and its consequences is a sure indicator that waste dumps have over the years gained the attention of man, perhaps because of related pollution and resource depletion accompanying their existence. When rain falls, it filters through the pile of waste also known as refuse or garbage dissolving nutrients and any soluble substance, some of which are harmful to life leaching them out. These leached out rainwater is referred to as leachate and it may find its way into the groundwater or nearby water body polluting it. Polluted water body is a risk to life as residents who depends on it as a drinking water source may not be able to purify the water before consumption. In addition, some leachate that permeates through the subsoil can be a big source of pollution for the subsoil.

As humans get informed about the consequences and effects of open dump sites, it became obvious that more needs to be done to remedy reduced crop/plant yield, increased probability of erosion amongst others that could result from inefficient/ineffective waste management system. In some quarters lining the dumpsite and pushing for controlled waste burning have been employed yet a well-engineered system where wealth can be harness from the system, pollutants contained and drained out for treatment with robust Extended Producer Responsibility approach as an alternative method of waste management is essential.

II. Literature Review

This literature review provides foundation knowledge to similar studies and acknowledges researchers approaches to work. It shows an overview of provision and efforts employed in the study of partial environmental engineering management study of open dump site and its impact on land and Water. The review focuses on waste generation because quantity produced has a directly proportional relationship with the amount of contaminants where they exist, factors

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affecting solid waste, waste collection and disposal, waste management, and its attendant environmental problems. Waste is a residue from a conversion process, which is no longer useful to the process or system. It could be gaseous or non-gaseous. The non-gaseous waste can generally be referred to as municipal solid waste (msw). They can be classified based on origin; created within and disposed of by a municipality. They include but not limited to household garbage, commercial refuse, and waste from government establishments and recreational facilities [2].

Onwughara et al [3], cited the Department of Environmental Quality Promotion stating that the majority of substances composing msw include paper, vegetable matter, plastics, metals, textiles, rubber and glass. Arguably increased number of commercial activities and densely populated residential areas will simultaneously trigger increased waste creation and consequently high discharge rate.

TABLE 1: ESTIMATED VOLUME OF WASTE GENERATED IN FIVE CITIES [4]

S/N	Year	Cities	Estimated volume of waste generated (tons)
1	2007	Kaduna	4,313,124
2	2007	Onitsha	386,593
3	2007	Aba	236,703
4	2007	New Bussa	9,518
5	2007	Uyo	20,923

Ordinarily it will be observed that old suburban settlements do not receive any meaningful waste collection and disposal services. Reckless waste handling contributed to blockage of cesspools and drainage systems, affecting water bodies [5]. In Nigeria waste generation in the various states depends on the population, development level of the town, socio-economic status of the citizens and the kinds of commercial activities in the area. Waste generation rate in Nigeria has been estimated at 0.65 to 0.95 kg/capita/day amounting to an average of 42 million tons of waste generated every year [6]. The country like most developing states do not have any national waste management plan and if any exist in any of the states, it is likely it will not be substantial [7]. In Ibadan, Oyo State 0.71 kg/capital/ day of waste is produced and general average of 0.58 kg/capital/day in other Nigerian towns [8]. Binefeigha and Enwin quoted Igoni as documenting that a total of 1,505,106 kg of solid waste are produced in Port Harcourt on a daily basis [9]. Table 1 above represents the estimated report by Oluwemimo [4], in tons for the listed States. Records from existing literature on solid waste generation in Abia State puts waste from food/putrescible waste at mean value of 3.67 kg in Umuahia and 4.59 kg in Aba within seven (7) days, 14.69 kg and 18.36 kg in Umuahia and Aba respectively over a period of four (4) weeks [10]. Onwughara et al [3] cited ASEPA, (2007) while stating that generated waste in Umuahia, Abia State, contains 2% of wastes from Individuals, 6% from Households, 12% from corporate bodies and 80% from market. These figures are pointer to the enormous waste generation that characterized most cities in Nigeria.

III. ISSUES SURROUNDING WASTE GENERATION / HANDLING

Solid waste handling/management in developing nations vary from those of developed nations. Incinerators, federal regulated landfill systems are used in the United States [11]. Sweden recycled almost all its waste and Germany uses effective recycling just like Austria, Switzerland and South Korea [12]. Several factors influence the solid waste generation, disposal and in Nigeria. Neglect to Engineers involvement/best engineering practices in waste management leading to mundane waste management systems. Most practiced waste management in many open dumps lacked containment facility. Lack of separation facility at source, inefficient waste management policy and enforcement, and awareness among others are factors affecting solid waste management. Education, income and social status are important factors influencing waste generation in some quarters too. In some other areas age, occupation and amount charged for waste handling, are determinants affecting waste generation [13]. Composition of waste and quantity also varies with political, economic and commercial activities [14].

Traditionally, managing waste starts from its source through collection, involving other activities to final effort of reducing their effect on human health or local amenity. Recently science and technology centering on design, building and use of engines, machines and structures, which form the core of engineering practice has been employed in the management of waste. However, poverty, increased migration to urban areas and insufficient funding of relevant agencies prevent efficient management of wastes. Collection and disposal of wastes differ from country to country.

Countries like Nigeria with population surging up to two hundred million (200) million, to be experiencing indiscriminately dumping of garbage on roadsides and any available open pits irrespective of the health implication on people and scavengers at dump sites is worrisome. Waste management have continued to fluctuate on any improvement scale ever. All types of waste are collected and dumped with little or no effort at segregating the constituents for proper handling. Dumpsites near streams receive frequent emptying of waste from nearby residence [15]. These deposits of solid wastes in the rivers and streams of emerging economies are bound to alter the experience or quality of ground water body. The changes that could be experienced can result to a major source of portable water pollution making these water sources unfit for human consumption. Unfortunately, Nigeria has been noted as one of the developing countries having serious challenges of managing their increasing solid waste generation [16]

It will not be out of place to intensify wake up calls to change the narrative in these economies and any town where inadequate dumpsites management are treated with levity. Unfortunately, some of these areas are often converted to farmlands with less befitting treatment if any at all. Plants grown in such soils expectedly poses a serious heath challenge as accumulated toxics in plants tissues finds its way into human organs. The unfortunate ugly sights that greets any traveler using highways in most developing nations are road side open dumps and pockets of dumps at the sides of the roads worsening the aesthetic state of places.

The Federal government of Nigeria in a swift move to mitigate and probably abate the menace of these ground water pollution and soil devaluation sources promulgate Decree 58 for the establishment of Federal Environmental Protection Agency (FEPA) on 30 December 1988 [17]. This action birthed a commendable policy on environment, which seek to among others: secure for all Nigerians a quality of environment, adequate for their health and wellbeing; to raise public awareness and promote understanding of the essential linkages between the environment and development; and to encourage individual and community participation in environmental protection and improvement efforts [18]. Handling of solid waste and/(or) managing it in an environmentally friendly manner was expected afterwards, yet improvement cannot be measured satisfactorily against investment. Abia State environmental Protection agency (ASEPA) has publicly committed a fighting spirit in battling the increasing volume of waste yet more still needs to be done. This research supports the idea of getting Engineers on boards for efficient technological approach, synergizing with government policy and enforcing same for improved services. No doubt FEPA s good mandate for waste handling, instituting and enforcement of laws, regulations, and standards; encouragement of public participation; awareness environment monitoring and imposition of penalties on defaulters to encourage compliance [17] are great tool when well implemented. .

Several waste management concepts born out of intense research and improvement efforts exist. While all has the ultimate goal of improved waste management, they differ in methodology and output. Listed below include a handful of some of these concepts:

1. Waste hierarchy – The hierarchy shows a system designed for maximum prevention of waste. In this system products are prepared for reuse, recycling, other possible recovery and the final disposal [19]. This method classifies waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy serves as the keystone of most waste minimization processes or systems. The aim of the waste hierarchy is to extract the maximum possible value from products and to produce the minimum amount of waste.
2. Land filling – wastes are disposed into a natural dug holes and covered with earth material. Some landfills are well lined and constructed in a way that waste are buried under safe and sanitary waste disposal process. Landfills are usually mapped out at a designated areas that favors waste reduction.
3. Incineration - controlled combustion of combustible waste after sorting.
4. Composting this is an organized and systematic means of naturally breaking down decomposable waste.
5. Polluter pays principle in this waste concept, authorities ensures that whoever that discharges refuse in an unauthorized manner is made to pay for his or her action/(s) and possible impact caused to the environment.
6. Extended Producer Responsibility (EPR). EPR concept puts in place measures that oversees the originators of goods managing the waste created from his/her products.
7. Integrated Product Policy (IPP) aimed at maximizing the most effective design, designing a product or processes to use fewer resources during its lifetime, or seeking process efficiency. All these concepts engineered into existence by constant and massive research are peculiar to locality and functionality.

Notwithstanding, for a fruitful solid waste management in Nigeria a holistic program that will assimilate all the technical, cultural, economic, and psychological factors that are often ignored in solid waste management must be in place. Non-renewable resources must be used at a judicious rate neither too fast nor too slow and to ensure that natural wealth that they represent is converted into long time wealth as they are used [20]. This is what a well-engineered waste management plan alongside Extended Producer Responsibility (EPR) approach to management of open dumpsite has to offer.

IV. Associated Environmental Engineering Issues

Outside pollution effects, some disasters have been traced to aftereffects of open dump sites. A study related flooding in Aba to refuse which litter and filled the roads particularly during the raining season [21]. Meanwhile refuse burning sometimes take place in these open dumps releasing toxic gaseous substances into the environment. Where abandoned and unused electronic, chemical waste and hazardous materials are burned, they greatly jeopardize scavengers health due to direct inhaling of these smokes [22].

A full study of the impacts of open dump sites involves consideration of a several number of components. In general, the environmental engineering impacts includes amongst others: Global warming, acidification, water contamination from fertilizer related waste and waste from land. The emission of landfill gases (LFGs) produced by the anaerobic and aerobic decomposition of organic matter is a major source of greenhouse gases (GHG), which are responsible for global warming and ozone depletion [3]. Studies prove that depletion of Ozone can result in crop yield decrease and capable of affecting rate of growth in plant. The depletion causes excess evaporation of water from the soil reducing the available water for plant growth, it also leads to flooding, which washes away plant nutrients aside high probability of damages to structures and colossal loss of materials/personnel.

Soil degradation impairs the capacity of the soil to perform ecosystem services, which includes those of agro-ecosystem. Additionally, it could affect its load bearing capacity for structures and urban system that support society development. Soil pollution from potentially toxic chemical ions such as arsenic, cadmium, lead and mercury are of great concern. Many potential toxic chemical ions are essential for animal and plant growth but in high concentration or long term exposure they become toxic. They can be transferred from soil to crop and water and ultimately affect human health [23].

Soil degradation processes often do not act individually and effect more than one soil parameter. Many soils naturally contain potential toxic chemical constituents that can be soluble under certain conditions. The knowledge of partial environmental engineering management study of open dump site and its impact on land and water is necessary to ascertain whether the dumpsite is increasing the concentration of these chemical constituents. In the light of the foregoing, obsolete products which consequently increases waste is expected in situations and places lacking good engineered waste management plan. Products with minimal recycling nature dominates such dumps and initial design of products or manufacturing style patterned to give products end use a second value is crucial not only to ameliorates the prevailing conditions but also maximize resources use. Most commercial cities especially in the developing countries may not take upon themselves to recycle materials or at least have any such plans for the future possibly due to lack of technological know-how, ignorance or fund.

Efforts have been made in this work to inflate the knowledge of waste creation, disposal, and management by reviewing the available literatures, evaluating the data presented and making empirical conclusion. The paper exposes partial environmental engineering management study of open dump site and its impact on land and water of the study area; it raises awareness on the environmental health implication of the dumpsite and encouraged appropriate authorities to increase their effort in combating the effects of solid waste creation and management. Indices obtained from this research could be factored into the design of water boreholes and waste management to achieve an economic environmentally friendly waste management.

V. MATERIALS AND METHODS

The study estimated from visual identification combined with partial measurement that the site is about 14000sqm or 1.4Ha and lies about forty meters (40) east of Aba Enugu expressway. The sampling for soils were done at a depth ranging from 0.3m □ 2.5m using an adjustable hand auger. The sampling point was geo-referenced using a hand held Garmin GPSMAP 62 model Geographical Positioning System (GPS) and water samples were collected in line with best sampling methods. Rough/estimated waste composition in the area showed values contained in the Table below:

TABLE 2: ESTIMATED WASTE PERCENTAGE COMPOSITION

Waste Composition	Percentage Composition
Food processing wastes and metal scraps wastes; (Polythene Materials nylon and containers)	30.6
Metallic objects (damaged vehicles and trucks parts)	16.3
Leaves, garden debris, trimming, pruning.	10.2
Construction/Demolition waste; (furniture/ wood materials, lumber Scraps, piping pieces, waste cement mixtures)	13.5
Uncategorized Waste	1.7
Highly flammable explosive and hospitals)	1

Source: Research findings.

The Soil sampling plan consisted of eight (8) sampling points that were located within the open dumpsite. Samples collected from the northern side of the site were analyzed as a composite sample while those from the Southern part were also analyzed as a composite sample. The soil samples used as control were collected at a depth of about 30cm for the surface sample and at about 2.5m for the subsurface sample from an unaffected area around the study area and analyzed separately for the already mentioned parameters. The soil samples collected were done using a random sampling method down to about 2.5m depth. Spatula was used to slice off the sides of the hand held auger when pulled out from the required depth before taken the soil samples from the tip of the auger. Sampling tools were washed with water and dried before the next sample was collected. The samples were put into appropriately labeled, containers and later analyzed for their quality and content.

The water samples were collected from two major sources: surface water and groundwater samples from the borehole (aquifer). The surface water samples were collected from upstream locations, center locations and downstream locations. Surface water was collected using appropriate bottles and labeled accordingly. Water was drawn from groundwater through a borehole drilled up to approximate depth of 60m designated as control. The water collecting containers were rinsed several times with the sample to be analyzed before samples were taken for analysis. The surface water samples were analyzed separately for the quality state. The groundwater water sample was also analyzed, and the analysis results recorded.

Two truckloads of waste were sorted under maximum hygienic condition with the assistance of the waste workers and its components were weighed and recorded. Eight (8) one cubic metre waste samples were collected randomly within the dump site and sorted. The sorted wastes were weighed, and their average recorded in percentage. The waste dump serves as a sink to many parts of the Aba metropolis. Waste collected from waste receptacles placed at some parts of Ogborhill zone, Port Harcourt road, Aba-Owerri road, Ariara Market and Asa road to Osisioma Junction, Abia Polytechnic, School Road, Seven-up firm, Umuigwe and Umuaduru communities, Breweries factory, Ngwa road and its environs, Teaching Hospital and Osisioma area find its way to the dumpsite. Indeed, the waste dump is one of the largest in the entire Aba metropolis.

The textural characteristics of the soil where the dumpsite is situated, which unvaryingly as expected will play a part in influencing leachate migration rate shows sand content of 47.7% of the total content. This outcome agrees with existing records regarding the topography of the area. [24]. Sandy soils are porous in nature and freely permeable. Consequently, plume from dumpsites will migrate unrestricted or with little restriction into the unconfined aquifer, contaminating the groundwater system with time.

The compaction process of waste management in place may limit/reduce pore spaces and minimize soil water volume/movement. However, evidence of soil and possible water source pollution with time due to constant movement of contaminants and build up in the dumps was noticed. Secondly, although contaminants at the moment is restricted to the topsoil continue use of the dump without well engineered structure and adequate waste management systems in place to impede downwards movement, stands the risk of polluting the subsoil in the near future. The above situation will arise due to the areas soil type and any other area of similar nature or composition will likely experience same effect. Meanwhile, available literature and findings show that the ground water within the area is yet to be contaminated. A drill log obtained from a borehole drilled at the study area revealed a firm soil formation as shown in Fig. 1.

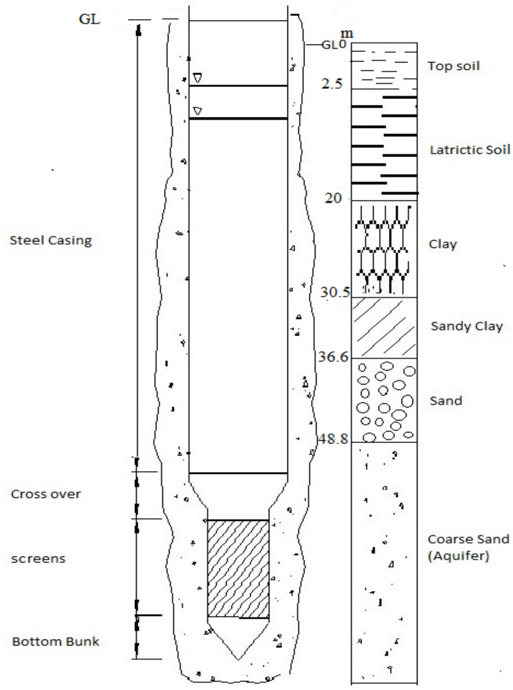

Fig. 1. Lithology identification profile of a borehole at the study area.

VI. Results And Discussion

Water as a universal solvent dissolves some locked up elements as it seeps through the waste, accelerating the decomposition of the degradable substance within the dump. The decomposition process could consume any available oxygen creating a favorable denifrication environment capable of establishing imbalance both in crop yield and atmosphere. Elevated temperature reduces pH values dissolving rather insoluble ions and adversely altering existing chemical composition.

The colour index for the water sample (control) showed a value of 3.0 TCU, turbidity 5.0NTU. The control showed clearly no visual defect, with no smell and no taste. The quality state of the ground water could be assumed to be free from impurities. This result is consistent with the findings of Adindu et al [25] regarding the ground water quality around the area. The sample quality falls within Nigerian Standard for drinking water acceptable quality limit, in addition to WHO specified limit [26]. The surface water samples are dark brownish in colour suggesting possible oxidation of iron elements in the site to ferric hydroxide colloids.

pH: The pH result from the surface water showed alkaline values due to soluble mineral salts from the waste dump been washed away with the water while the control sample value is slightly acidic. Water sample pH from the control (Borehole Sample) is 6.43 and the surface water samples values ranged from 7.38-8.43. The acidic value of the control sample against the alkaline state of the surface water could be an indication that groundwater is free from the content of the surface water. Soil samples pH indicated a shift from the neutral state in the soil control samples with values of 7.13 and 7.48 to acidity values of 6.28 and 5.98 in the waste dump area.

Electrical conductivity (EC): EC of water samples ranged from a very low value of 183.33 µs/cm in the control water sample to 812.77 µs/cm in the surface water sample from the dumpsite. The low salinity of the control water sample indicates low mineral content. The high Salinity of the surface water samples leads to suspicion that the surface water of the waste dumpsite is in contact with inorganic constituents materials.

Total Dissolved Solids (TDS): The water sample (control) shows a TDS value of 110.00 mg/l. Those obtained from the surface water samples ranged from 448.9-487.66 mg/l. Total Dissolved Solids are classified as a secondary contaminant by the Environmental Protection Agency (EPA) and a suggested maximum is 500 ppm [18].

Lead, Arsenic (As), Cadmium (Cd), Iron (Fe) and Mercury (Hg): From the analysis result, the heavy metals in the soil samples have values of $<1 \times 10^{-3}$ mg/kg for As, Pb, Cd and Hg in both the soil control and the dumpsite with Iron ranging from 0.195 mg/kg in the control sample to as high as 7.344 mg/kg in the dumpsite. For the surface water samples As, Pb, Cd and Hg have values of $<1 \times 10^{-3}$ mg/kg for both the surface water and the control sample with Iron ranging from 0.058 mg/kg (control sample) to 5.926 mg/kg outside the control. The presence of heavy metals in drinking water is of great concerns to human health. Arsenic above 0.1 mg/l in drinking water can cause cancer. Above 0.01 mg/l Lead content in drinking water can cause cancer too, interfere with vitamin D reaction and causes hypertension with retarded mental development. Lead is equally toxic to both the central and peripheral nervous system [26]. Cadmium is toxic to the kidney likewise; mercury affects the kidney and the central nervous system [26]. Excess iron gets deposited in human organs, such as the pancreas and liver. Cirrhosis, cancer, cardiac arrhythmias and diabetes can be traced to excess iron, Brody [27]. However, Nigerian Standards for Drinking water quality (NSDWQ) [28] publication puts Iron maximum permitted value of 0.3 and insignificant health challenge in excess. Except for Iron, these metals were detected in very insignificant quantities in both soil and water samples. These low levels of Cd, As, Pb and Hg is an indication of absence of industrial waste from the manufacturers of insecticides as well as deposition of aerosols particles.

Chloride: There exists an increase in the values of chloride in the soil samples when compared with the values obtained from the control. The surface water samples also showed an increase in values when compared with the value obtained from the control. The chloride concentration in the soil samples ranged from 10.00 mg/kg 50 mg/kg in the dumpsite and 10.00 mg/kg in the control. The water samples have concentration ranging from 80.00 mg/l in the control sample to 403 mg/l in the sample from the dumpsite. The elevated chloride values of the surface water samples of the waste dump could be an indication of a soluble salt-related waste being dumped in the dumpsite, hence the salt accumulation. In spite of this high Chloride value in the surface water, the control sample value of 80 mg/l indicates that the groundwater is not impacted and it is still below the Nigerian Standard for Drinking Water Quality value of 250 mg/l NSDWQ [28]

Nitrate and Nitrite: Reduction of nitrates leads to nitrites. Nitrates polluted water is a risk to human health when consumed, it could lead to several adverse health effects, possible conversion of hemoglobin to methemoglobin, which cannot carry oxygen [29]. Health implications of nitrate and nitrite according to NSDWQ [28] are Cyanosis and asphyxia in children under the age of three (3) months. There is an increase in the value of nitrite and nitrate in both the soil and water samples from the dumpsite when compared with their controls. The result of the analysis shows nitrate values ranging from 71.71 mg/kg to 109.8 mg/kg in the soil samples against 19.04 mg/kg obtained in the soil control. The nitrite analysis shows values ranging from 4.00 mg/kg to 6.00 mg/kg in the soil samples against <0.001 mg/kg from the control. For the water samples, nitrate values range from 44.27 mg/l - 57.55 mg/l against 5.357 mg/l from the control sample and nitrite values of 17.00 mg/l - 21.00 mg/l against 1.00 mg/l in the control. The variation in the result of the analysis is because of their concentration at the various locations. It is evident that nitrite contamination is possible as the analysis result of the control water sample slightly increased when compared to the permissible value of 0.2 mg/l for drinking water (NSDWQ [28]. Both the nitrate and nitrite have accumulated in the dumpsite samples.

Phosphate and Sulphate: A slight Phosphate accumulation in both soil and water samples is evident from the result of the analysis when benchmarked with the values from the control areas. The values obtained ranged from 0.1 mg/kg to 0.90 mg/kg in the dumpsite against <0.001 mg/kg in the soil control sample and 0.83 mg/kg to 1.08 mg/kg in the surface water samples against 0.179 mg/kg obtained from the control. There is equally an increase in sulphate values in both the soil and water samples. The sulphate values ranged from 4.00 mg/kg to 15.00 mg/kg in the dumpsite against 3.00 mg/kg in the soil control sample and 10.00 mg/l to 26.00 mg/l in the surface water samples against 5.00 mg/l in the control. The values obtained still fall under the maximum permissible limit of 100 mg/l NSDWQ, [28].

Bulk Density: this has a direct relation with soil compaction. The bulk density of the sampled soil from the study area is 2100kg/m^3 or 2.1g/cm^3. Standard values of bulk density for sandy soils are in the range of 1.3 g/cm ^{3} to 1.7 g/cm^3 [30]**.** Table 3 contains the common relationship of soil bulk density with the root growth with regards to soil texture according to Arshad et al [31]. Table 3 shows that bulk densities exceeding a certain limit or range indicates compromised state. Additionally, the ability of the soil to serve for structural support, soil aeration and solute movement can be derived from bulk density of the soil. A measure of bulk density of the soil is a direct measure of compaction effect, which alters soil strength, space size and distribution. Decreased in the soil pore space results to increase in the bulk density of the soil [32]. The high bulk density result of the study area is a pointer to how far the study area has been degraded for most agricultural plants when benchmarked with values of Table 3.

High bulk density resulting from reduced low porosity value can trigger erosion. Constraints to root movement or growth aside from the attendant impair plants growth could lead to poor infiltration of water into the soil hence creating a waterlogged surface and increase surface run-off.

TABLE 3: PARTLY EXTRACTED SOIL BULK DENSITY RELATIONSHIP WITH ROOT GROWTH BASED ON SOIL TEXTURE [31]

S/N	Soil Texture	Ideal bulk density for plant growth(g/cm^3)	Bulk densities that restrict root growth (g/cm^3)
1	Sandy	< 1.60	> 1.80
2	Silty	< 1.40	> 1.65
3	Clayey	< 1.10	> 1.47

Aeration-related problems could also result from high bulk density soils due to presence of few large pores. On the other hand high bulk density soils, an indicator of increased or high compaction increases the strength of the soil giving it increased load bearing capacity.

Porosity: porosity describes the fraction of void space in the material. Voids in materials are retaining spaces in materials, they may contain fluids, for example, water or gas. Porosity stays as the principal geologic factor that determines the storage capacity of an aquifer. However, capacity to replenish or recharge an aquifer depends on the water removed by the force of gravity [33]. The calculated porosity value of the area is 0.21 or 21%. The porosity representative value for sand lies within the range of 20% to 40% according to Prof T.K.S Abam (personal communication). The low porosity result from the study area is a further confirmation of soil compaction in the area. These results agree with reports regarding solid waste soil and water environmental impacts via contamination [3].

VII. CONCLUSIONS

The dumpsite, like most other similar dumpsites is gradually impacting on the land leading to damages to potential farmlands with accumulation of non-biodegradables and increasing soil acidity. The high volume of non-degradable agrees with the findings of Babatunde et al [34] concerning municipal solid waste in Nigeria. In the near future remedying the land will involve huge resources due to long time accumulation effect. Adequate measures need to be put in place to effectively manage these waste dump to avert human beings and the government from suffering severe inconveniences, which in turns puts unnecessary strain on public resources. Nitrite known to cause some health challenges when in excess are gradually building up. Some of the soil properties examined such as the soil texture, porosity and Sand content showed a natural formation that over time will exhibit a permeable characteristic. Aside accumulation, findings reveal that the area is experiencing increasing soil compaction hence should the permeable characteristic be overcome, the area may probably become prone to severe water logging or erosion.

The groundwater sample analysis reveals that the selected parameters of great concern analyzed during the research have values, which are below the Nigerian standards for drinking water quality limit. These values also fall below the World Health Organization (WHO) water quality limit. When benchmarked with the values obtained from the surface water in the dumpsite, the values of the parameters in the ground water sample revealed far less concentration. The high concentration of chloride may be as a result of a salt source from the dump. A waste management plan (wmp) for commercial cities should be of cradle to grave approach that will minimize the generation of solid waste. Technologically engineered Wmp that is capable of limiting flow to a restricted enclosed part of the dumpsite for evacuation and proper treatment should be put in place to avert possible pollution to water supply. The well-engineered effective waste management system, which will not only contain pollutants but ensure that producers incorporate measures that are capable of transforming waste to wealth will push to secure the lands too. Undoubtedly, this approach will be suitable for a country like Nigeria. The Extended Producer Responsibility (EPR) also known as Reverse Logistics, a system that mandates product manufacturers to exercise commitment in recycling their products consumed within and outside the manufactured country [4] is therefore recommended. This method when implemented with engineering principles, products manufacturing and handling will equally be less expensive to operate while maintaining a cleaner environment. The well-engineered waste management system that will now take care of the byproducts of EPR will minimize land and water pollution. However, advance research and efforts should be employed for accepting the most appropriate strategy for their implementation.

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