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Comparative Assessment of Domestic Effluent Discharge on Water Quality

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Abstract: **This study was carried out to investigate the comparative assessment of domestic sewage discharge on water quality at Edjeba sewage treatment plant, Warri, Delta state. The pH, temperature, electrical conductivity, TDS, DO, TSS, turbidity, BOD, COD, oil and grease, salinity as chloride, sulphate, total nitrogen, hydrogen sulphide, iron, zinc, copper, chromium, Arsenic, mercury and total coliform test was carried out on the untreated sewage, treated sewage and sample from the recipient environment. The physicochemical parameters of the untreated sewage, effluent and sample from the recipient environment were analysed using Standard Methods by American Public Health Association (APHA) and the results compared with the permissible limits of Federal Ministry of Environment (FMEnv). The result obtained indicated a pH of 6.42, temperature of 29.9°C, electrical conductivity of 624µs/cm, Dissolved Oxygen (DO) of 0.85mg/l, turbidity of 15NTU, Biochemical Oxygen Demand (BOD) of 20.50mg/l, Chemical Oxygen Demand (COD) of 22.45mg/l, iron (Fe) of 2.31mg/l and total coliform of 280mpn/100ml for untreated sewage. These values exceeded the effluent discharge limits of FMEnv. The physiochemical analysis results carried out on the effluent and sample from recipient environment showed that the values were all within permissible limits for discharge. The study therefore concluded that untreated sewage from Edjeba sewage treatment plant, if discharged to the recipient environment without prior treatment will cause pollution. Also, based on the results obtained, the effluent was safe for discharge without concerns for public health issues. It was recommended that proper maintenance of the existing central sewage treatment facility should be ensured for effective sewage treatment to avert potential public health risk.**

Keywords: **assessment, untreated sewage, discharge, treatment, physiochemical, effluent, sample, parameter, permissible limit, public health, comparative, environment, pollution.**

1. INTRODUCTION

The discharge of wastewater from source into surface waters and the resultant deleterious changes in water ecology have been reported by previous studies. [1] Okoronkwo and Odeyemi[2]; Odokuma and Okpokwasili[3] expressed serious concern over human health and the possible accumulation of pathogenic microorganisms by aquatic organisms. Incidences of water-borne infections in communities of developing countries resulted to death of millions of people [4]. Some of these deaths were traceable to the use of waters polluted by untreated waste [5][6]. Akpata and Ekundayo [7] in their research confirmed that there was increase in the number of total coliforms and of *E.Coli*in particular when faeces were added to the Lagos lagoon. Okoronkwo and Odeyemi, [8] showed similar trend in the pollution of a stream by wastewater from a sewage dumpsite.

Egborge and Benka-Coker [9] research indicated a relatively higher coliform loads at stations on Warri River that received wastewater matter from slaughterhouses and raw human sewage.

The discharge of wastewater from bathroom, laundry, slaughter centre etc have been a major cause of the deterioration of most tropical rivers as they pass through inhabited areas [10]. The effect of uncontrolled disposal of sewage makes surface waters and underground water systems unfit for human usage, agricultural and recreational purposes; it destroys biotic life, poisons the natural ecosystems, threatens human health and it is against the principles of sustainable development.

As the general public awareness increases, the financial expenditures for pollution control correspondingly increases. It therefore becomes necessary to prevent deterioration in the quality of life arising from rapid environmental degradation. It is reported that developing countries suffer from a number of primary environmental problems attributable to pollution and attendant poor living conditions. Added to this is the fact that numerous industries are fast springing up in different parts of the country, without any clear environmental blueprint.

Consequently, failure to begin waging an early war against environmental pollution today may likely result in embarrassing environmental issues with increased costs in the future. However, if the adverse effects of river pollution and spread of water borne diseases are to be mitigated, current environmental laws, enforcements and waste disposal practices should be reassessed [11]. The potential deleterious effects of pollutants from sewage on the receiving water quality of the coastal environment are manifold and depend on volume of the discharge, the chemical composition and concentrations in the effluent. It also depends on type of the discharge for example whether it is amount of suspended solids or organic matter or hazardous pollutants like heavy metals and organochlorines, and the characteristics of the receiving waters [12][13]. High levels of soluble organics may cause oxygen depletion [14] with a negative effect on aquatic biota. Contamination of the coastal water may result in changes in nutrient levels, abundance, biomass and diversity of organisms, bioaccumulation of organic and inorganic compounds and alteration of trophic interaction among species. Receiving waters with high flushing capacity are able to dilute or eliminate most of the conventional pollutants but persistent toxic compounds and long lived pathogens will always be troublesome.

2. MATERIAL AND METHODS

SAMPLE COLLECTION:

Untreated and treated sewage samples were collected from sewage treatment plant using standard methods and procedures. Samples were collected from the recipient environment where the treated sewage samples were discharged, all located in residential area. The important parameters considered in this study include: PH, Temperature, Dissolved Oxygen, Electrical Conductivity, Total Dissolve solids, Biochemical Oxygen Demand, Chemical Oxygen Demand, Sulphate, Oil and Grease, Total Suspended Solid, Turbidity, Salinity as Chloride, Total Nitrogen, Hydrogen Sulphide, Faecal Coliform and Heavy Metals. The containers used were carefully washed with 1% HNO_3 acid and rinsed with tap water and distilled water. It was drained before the samples were collected after rinsing with the wastewater sample. The samples were labelled appropriately and transported to the laboratory where it was refrigerated at 4^0C prior to analysis.

STUDY INSTRUMENTS: These include thermometer, pH meter, measuring cylinder, weighing balance, desiccators, separating funnel, beaker, pipette, filter, Erlenmeyer flask, magnetic stirrer, nitric acid digestion, Atomic Absorption Spectrophotometer. These instruments were of immense importance during laboratory analysis.

SAMPLE STORAGE AND PRESERVATION:

The samples were collected in a container and preserved according to the standard method of American Public Health Association (APHA).

Temperature, pH, conductivity, total dissolved solid, dissolve oxygen were measured immediately after sample collection. Standard procedures were strictly followed to ensure that all parameters were properly analysed and results were recorded accurately.

3. RESULTS AND DISCUSSIONS

The Table 1 below shows the results obtained from the analysis of untreated sewage, treated sewage and a sample from recipient environment as compared with Federal Ministry of Environment standards.

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Table1: Physio-chemical parameter result for studied Industrial Area

Parameters	Sample A (untreated)	Sample B (treated)	Sample C Recipient Environment	FMenv
pH	6.42	7.20	7.26	6.5-9.2
Temperature (^oC)	29.90	26.60	26.00	35
Electrical Conductivity (us/cm	1248.00	186.80	103.60	NS
Total Dissolved solids (mg/l)	624.0	93.40	51.90	2000
Dissolved Oxygen	0.85	4.00	3.10	NS
Total Suspended Solid (mg/l)	12.55	4.70	7.80	NS
Turbidity (NTU)	15.34	6.30	10.80	NS
Biochemical Oxygen demands (mg/l)	20.50	6.50	7.40	NS
Chemical Oxygen Demand (mg/l)	22.45	4.50	1.90	NS
Oil and grease (mg/l)	4.12	1.77	0.74	20
Salinity (mg/l)	542.45	49.85	31.82	600
Sulphate (mg/l)	10.70	12.40	10.70	NS
Total Nitrogen (mg/l)	1.45	0.51	0.43	NS
Hydro Sulphide (mg/l)	0.03	0.01	0.01	NS
Fe (mg/l)	2.31	0.22	0.35	1.0
Zn (mg/l)	0.78	0.32	0.28	1.0
Cu (mg/l	0.88	0.44	0.32	1.5
Cr (mg/l)	<0.001	<0.001	<0.001	0.03
As (mg/l)	<0.001	<0.001	<0.001	NS
Hg (mg/l0	<0.001	<0.001	<0.001	NS
Total Coliform MPN/100ml	280.00	39.45	35.00	NS

pH:

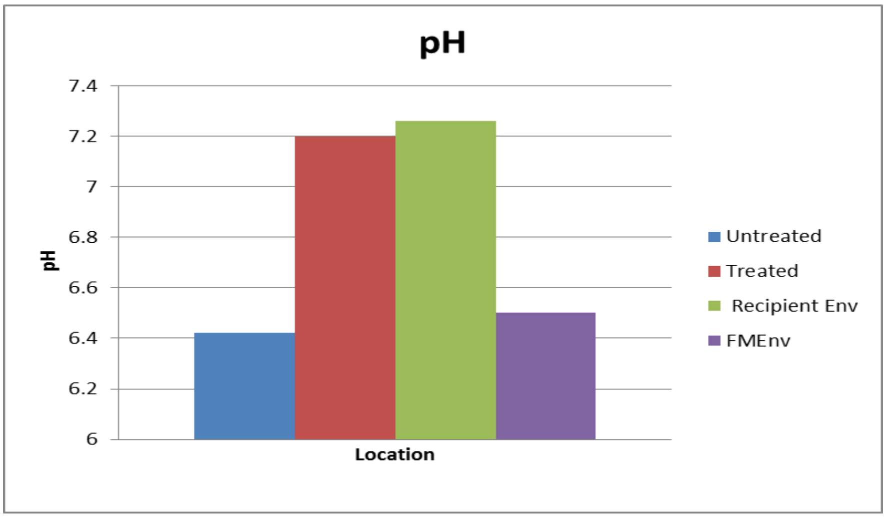

Figure 1: Comparison of pH samples untreated effluent, treated effluent, recipient environment with federal ministry of environment.

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Figure 1 indicates that the pH of untreated effluent is 6.42, treated effluent is 7.20 and recipient environment is 7.26 which conform to effluent quality limit of federal ministry of environment. The pH of untreated effluent could be lethal to biota if not properly treated.

Temperature:

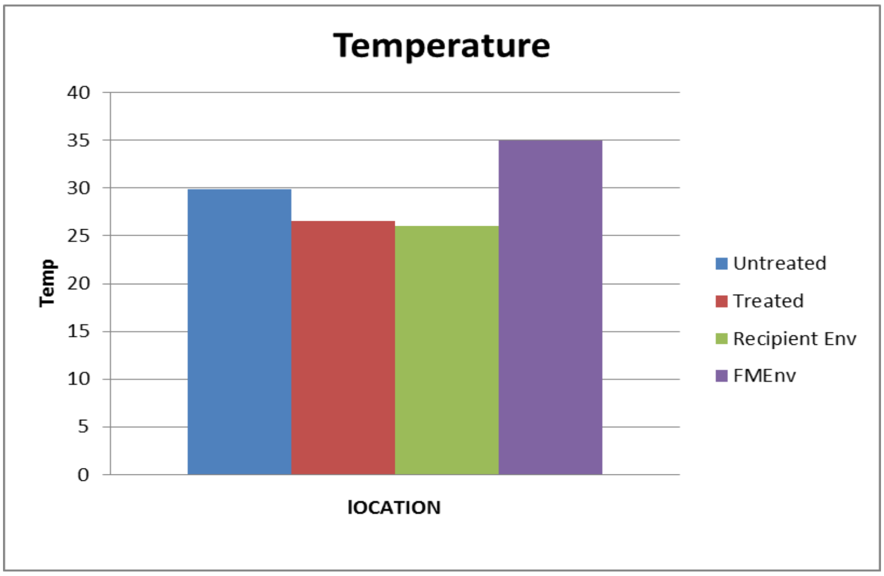

Figure 2: Comparison of temperature samples untreated effluent, treated effluent, recipient environment with federal ministry of environment.

Figure 2 indicates that the temperature of untreated effluent is 29.90^{0C}, treated effluent is 26.60^{0C} and recipient environment is 26.0^{0C} which conform to effluent quality limit of federal ministry of environment. The variation in temperature could be attributed to prevailing weather condition at the time samples were collected.

Electrical Conductivity:

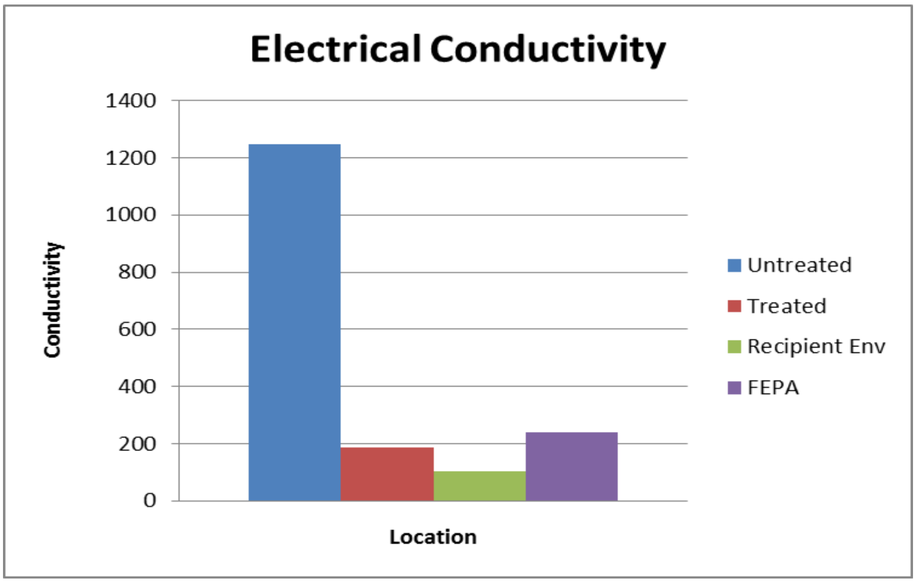

Figure 3 Comparison of electric conductivity samples untreated effluent, treated effluent, recipient environment with federal ministry of environment.

Figure 3 indicates that the electric conductivity of untreated effluent is 1,248µs/cm, treated effluent is 186.80 µs/cm and recipient environment is 103.6 µs/cm. The high electrical conductivity in the untreated effluence could be lethal to biota because it could increase their body pressure.

Total Dissolved Solids:

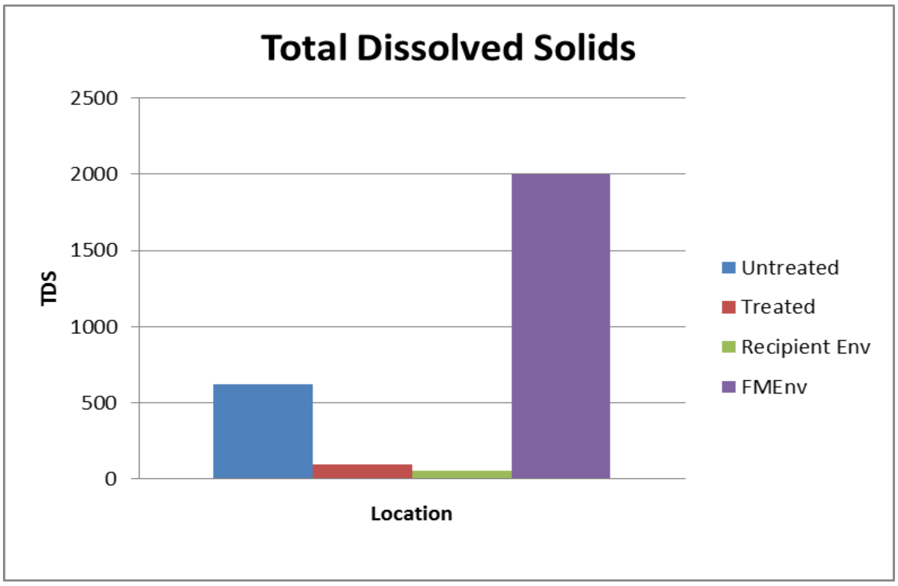

Figure 4 Comparison of total dissolved solids samples untreated effluent, treated effluent, recipient environment with federal ministry of environment.

Figure 4 indicates that the total dissolved solid of untreated effluent is 624mg/l, treated effluent is 93.40 mg/l and recipient environment is 51.9 mg/l. All the samples conform to permissible effluent quality limit of federal ministry of environment. However the variation in concentration of samples is as a result of treatment and dilution undergone by the effluent samples.

Dissolved Oxygen:

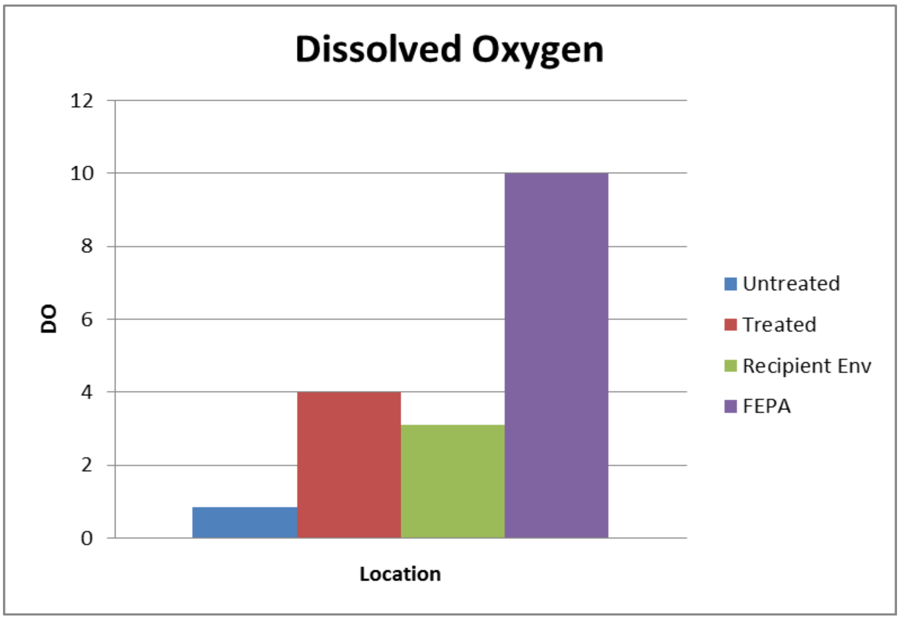

Figure 5 Comparison of dissolved oxygen samples untreated effluent, treated effluent, recipient environment with federal ministry of environment.

Figure 5 indicates that the dissolved oxygen of untreated effluent is 0.85mg/l, treated effluent is 4.0 mg/l and recipient environment is 3.10 mg/l. However, the Dissolved oxygen of the untreated effluent if discharged without proper treatment to the recipient environment could lead to environmental/organic pollution because it gives a measure of how clean a sample of water.

Total Suspended Solids:

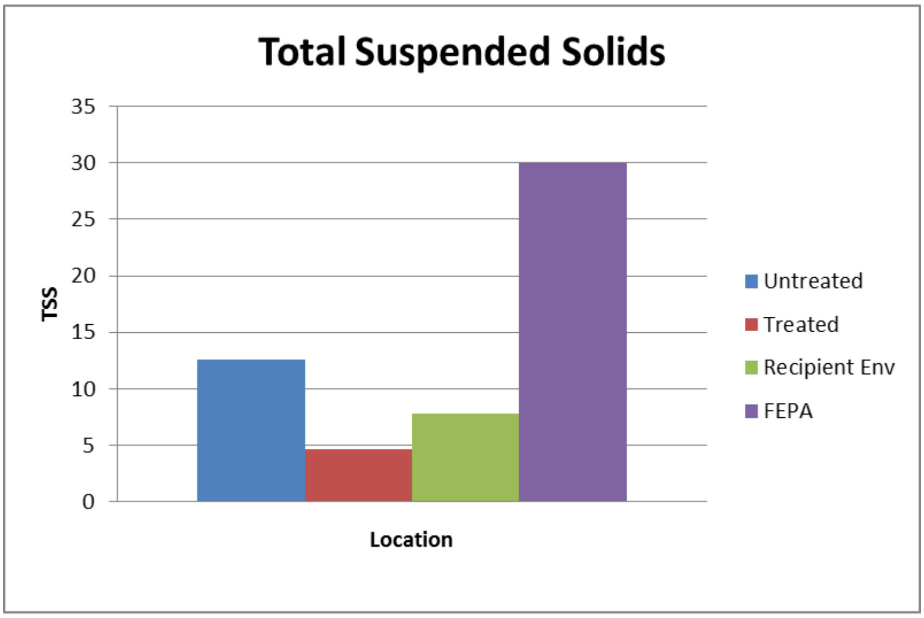

Figure 6 Comparison of total dissolved solids samples untreated effluent, treated effluent, recipient environment with federal ministry of environment.

Figure 6 indicates that the total suspended solid of untreated effluent is 12.55mg/l, treated effluent is 4.70mg/l and recipient environment is 7.80mg/l. However, the total suspended solid of the untreated effluent could increase the turbidity of the recipient environment if not properly treated.

Turbidity:

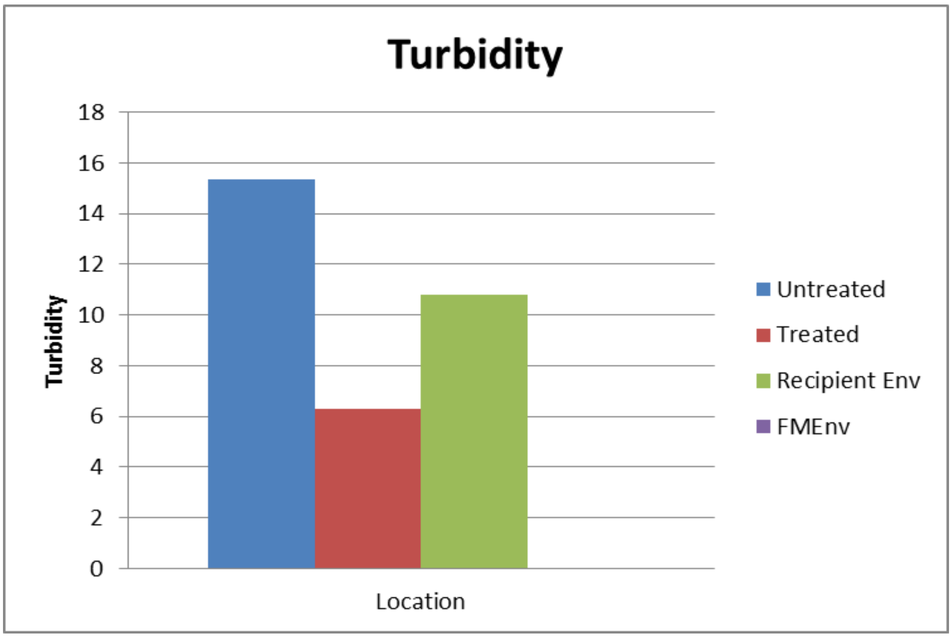

Figure 7 Comparison of turbidity samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment.

Figure 7 indicates that the turbidity of untreated effluent is 15.34NTU, treated effluent is 6.0 NTU and recipient environment is 10.80 NTU. However the turbidity of the untreated effluent could interfere with the passage of light through water.

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Biochemical Oxygen Demand:

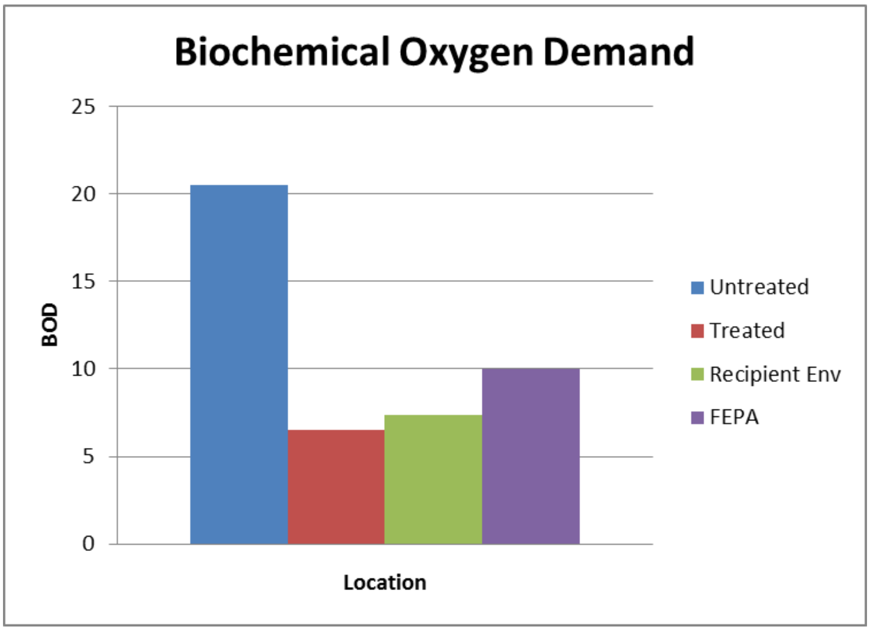

Figure 8 Comparison of biochemical oxygen demand of untreated effluent, treated effluent, recipient environment with federal ministry of environment.

Figure 8 indicates that the turbidity of untreated effluent is 20.50mg/l, treated effluent is 6.50mg/l and recipient environment is 7.40mg/l. The biochemical oxygen demand of the untreated effluent is an indication of pollution and could lead to reduction in biological stability which is as a result of reduction in dissolved oxygen if not properly treated. It could also lead to Eutrophication, increase in acidity or the alkalinity of the recipient environment.

Chemical Oxygen Demand:

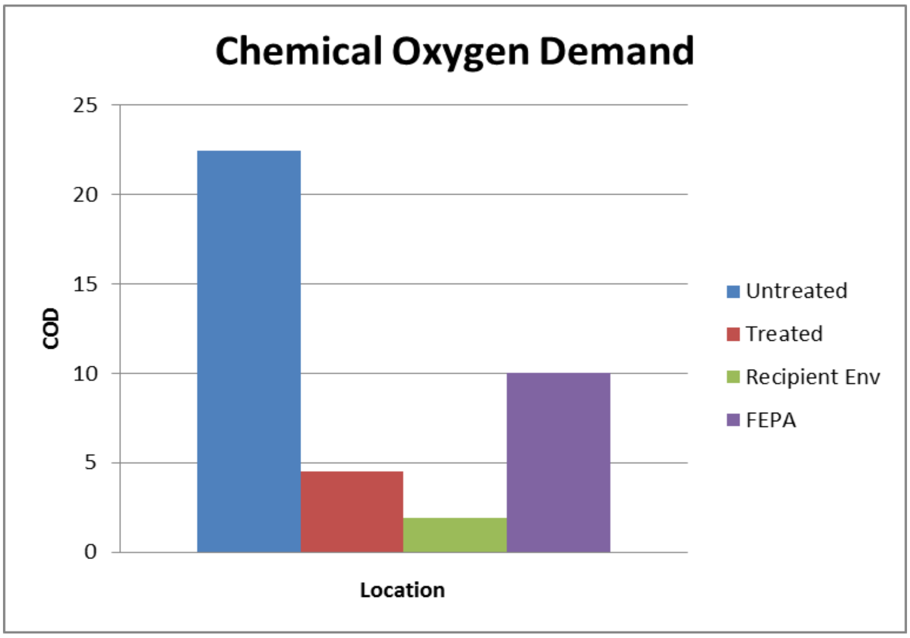

Figure 9 Comparison of chemical oxygen demand of untreated effluent, treated effluent and recipient environment.

Figure 9 indicates that the chemical oxygen demand of untreated effluent is 22.45mg/l, treated effluent is 4.50mg/l and recipient environment is 1.90mg/l. The chemical oxygen demand of the untreated effluent is an indication of pollution. It could also lead to Eutrophication, increase in acidity or the alkalinity of the recipient environment.

Oil and Grease:

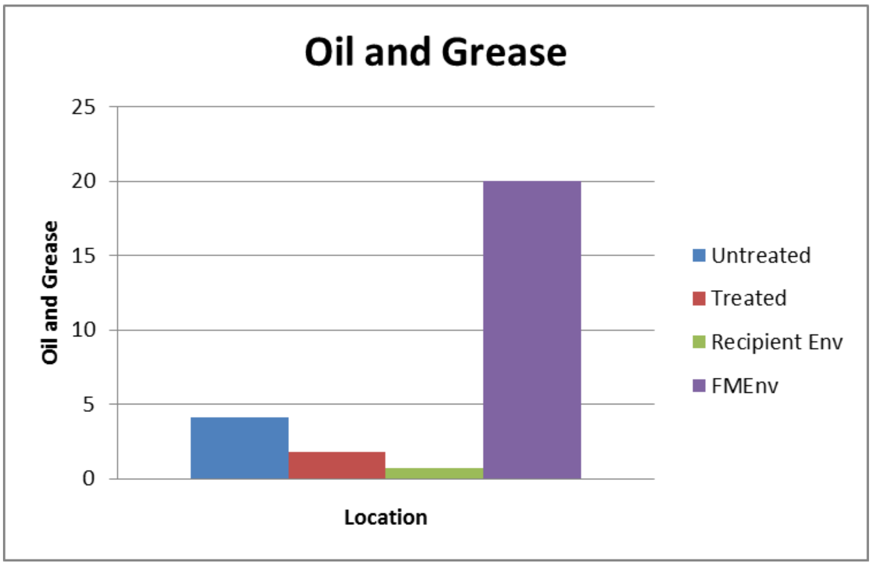

Figure 10: Comparison of oil and grease samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment

Figure 10 indicates that the oil and grease of untreated effluent is 4.12mg/l, treated effluent is 1.77mg/l and recipient environment is 0.74mg/l. All samples conform to the permissible effluent quality limit of federal ministry of environment which indicate that all samples do not cause pollution threat to the recipient environment. However, excess oil and grease content in the samples could be toxic to aquatic biota, partially soluble or insoluble in water. It could also create chemical oxygen demand. Low level of oil and grease pollution can also reduce aquatic organisms ability to reproduce and survive.

Salinity as Chloride:

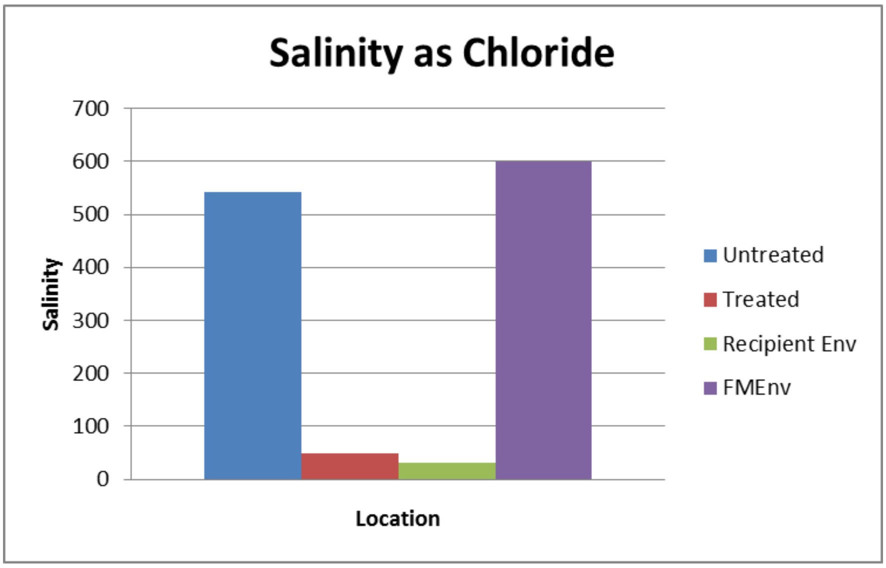

Figure 11: Comparison of salinity as chloride samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment

Figure 11 indicates that the salinity as chloride of untreated effluent is 542.45mg/l, treated effluent is 49.85mg/l and recipient environment is 31.82mg/l. All samples conform to permissible effluent quality limit of federal ministry of environment which is 600mg/l. However, excess salinity as chloride in water reduces dissolved oxygen which could affect aquatic biota and vegetations. It also reduces crop yield when impacted water is used for irrigation, damage infrastructure.

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Suphate:

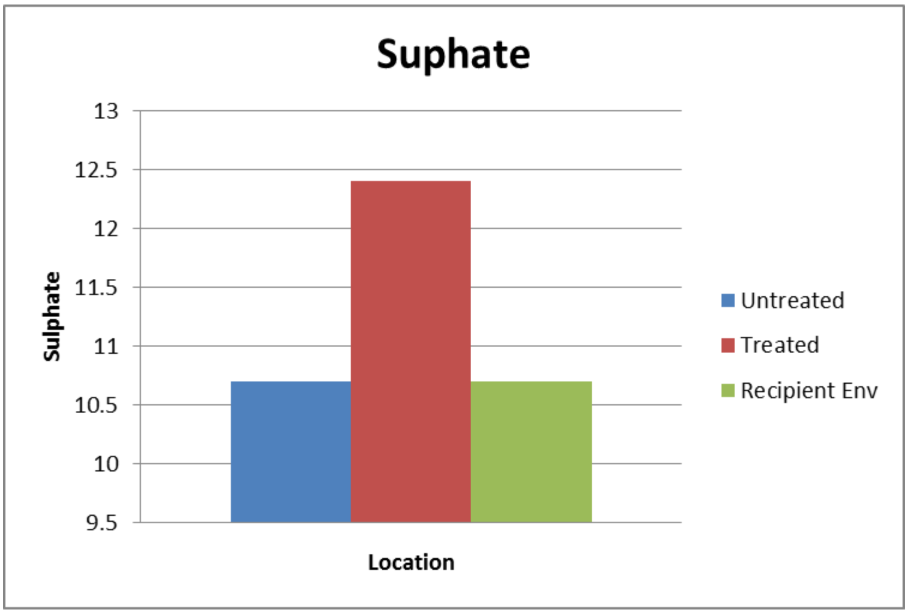

Figure 12: Comparison of suphate samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment

Figure 12 indicates that the suphate of untreated effluent is 10.70mg/l, treated effluent is 12.40mg/l and recipient environment is 10.70mg/l. There is no specified permissible limit by federal ministry of environment. However, excess suphate on the environment may be cathartic.

Total Nitrogen:

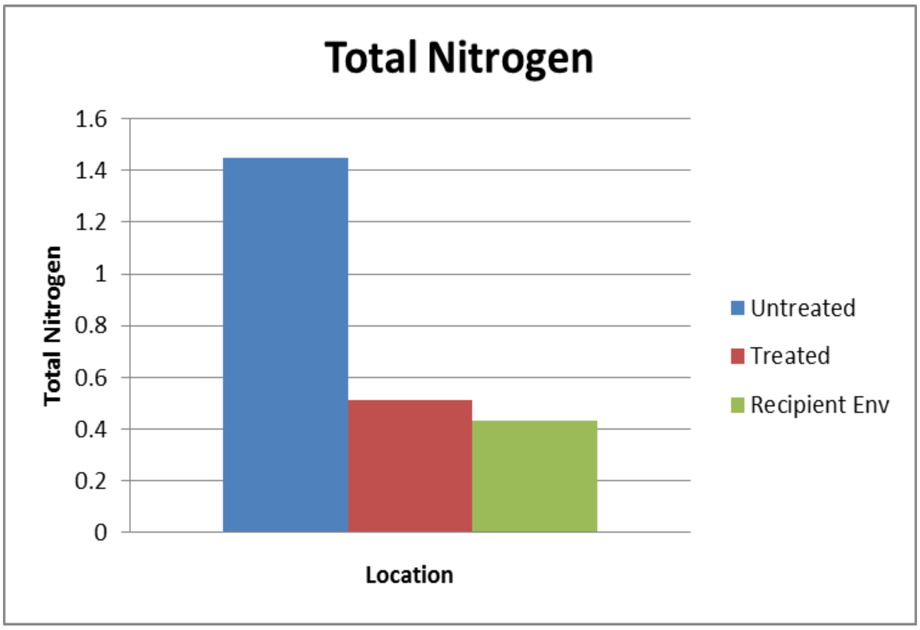

Figure 13: Comparison of total nitrogen samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment

Figure 13 indicates that the total nitrogen of untreated effluent is 1.45mg/l, treated effluent is 0.51mg/l and recipient environment is 0.43mg/l. There is no specified permissible limit by federal ministry of environment. Though excess total nitrogen could lead to eutrophication.

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Hydrogen Sulphide:

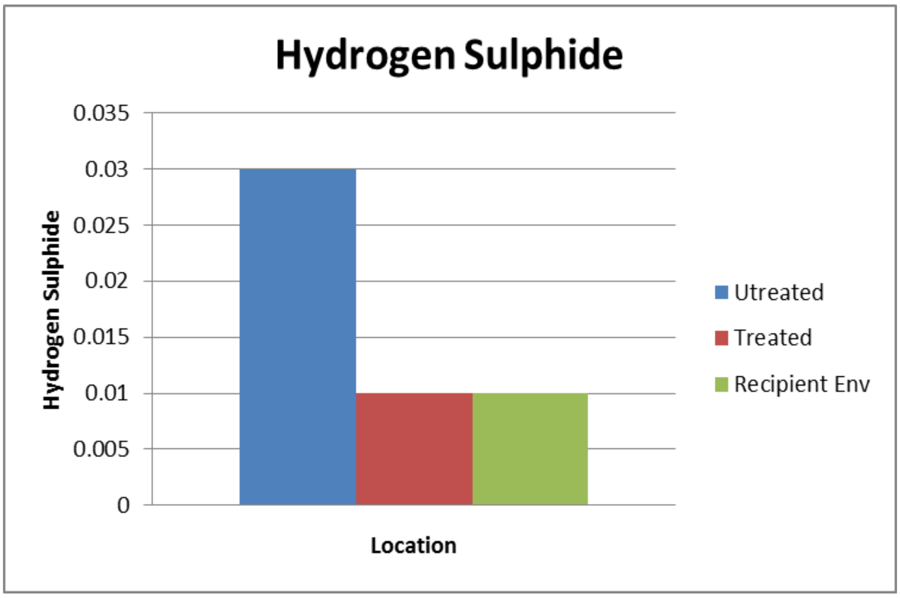

Figure 14: Comparison of hydrogen sulphide samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment

Figure 14 indicates that the hydrogen sulphide of untreated effluent is 0.3mg/l, treated effluent is 0.01mg/l and recipient environment is 0.01mg/l. There is no specified permissible limit by federal ministry of environment. Though excess concentration of hydrogen sulphide could lead to odour and also increase the acidity of the recipient environment.

Iron:

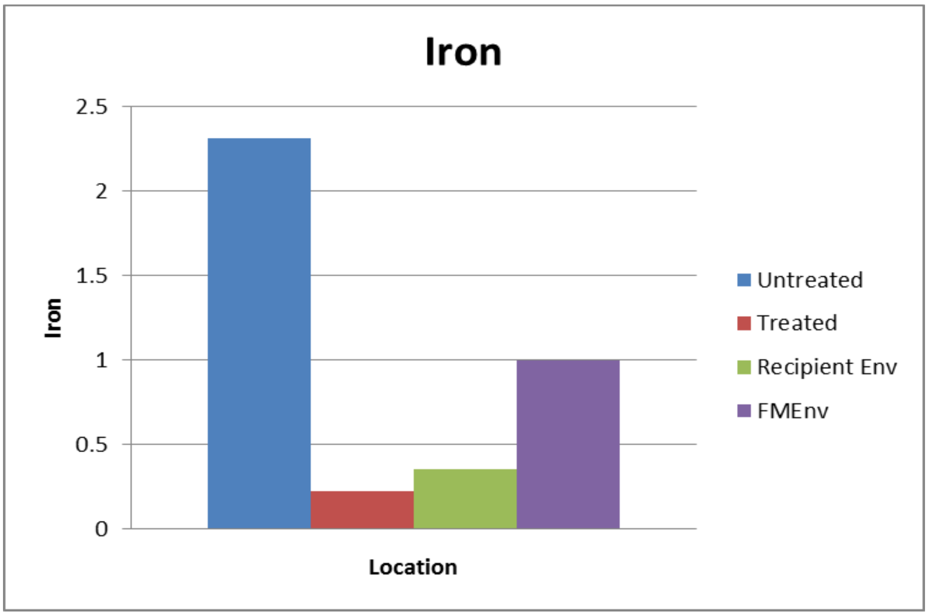

Figure 15: Comparison of iron samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment

Figure 15 indicates that the iron of untreated effluent is 2.31mg/l, treated effluent is 0.22mg/l and recipient environment is 0.35mg/l. The iron content of the untreated effluent exceeded the effluent quality limit of federal ministry of environment which is an indication of pollution. This could cause hardness of water, taste, odour, incrustation and heavy growth of iron bacteria in the recipient environment.

Zinc:

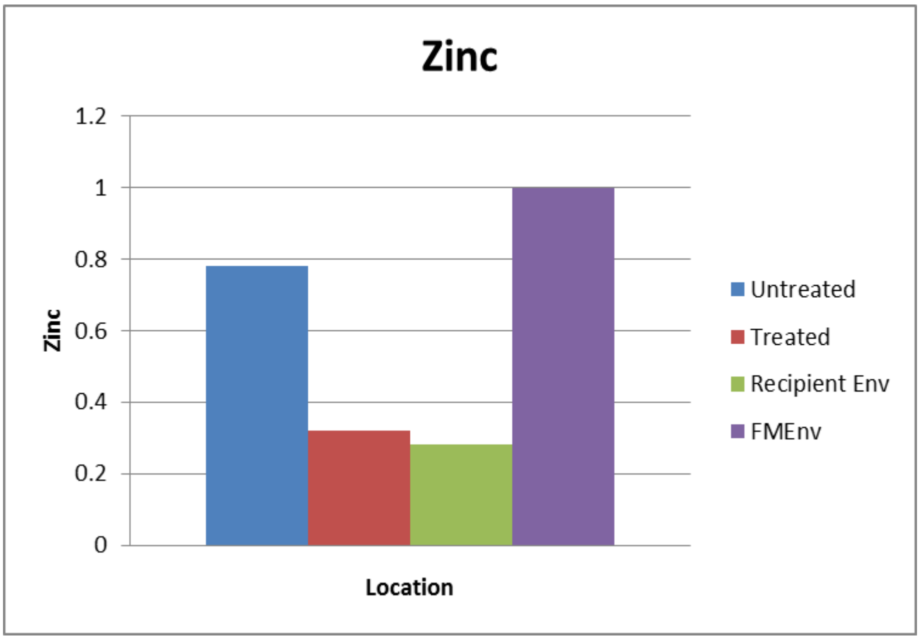

Figure 16: Comparison of zinc samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment.

Figure 16 indicates that the zinc of untreated effluent is 0;78mg/l, treated effluent is 0.32mg/l and recipient environment is 0.28mg/l. All samples conform to the permissible effluent quality limit of the federal ministry of environment which is 1.00mg/l, which indicates that there is no pollution potential.

Copper:

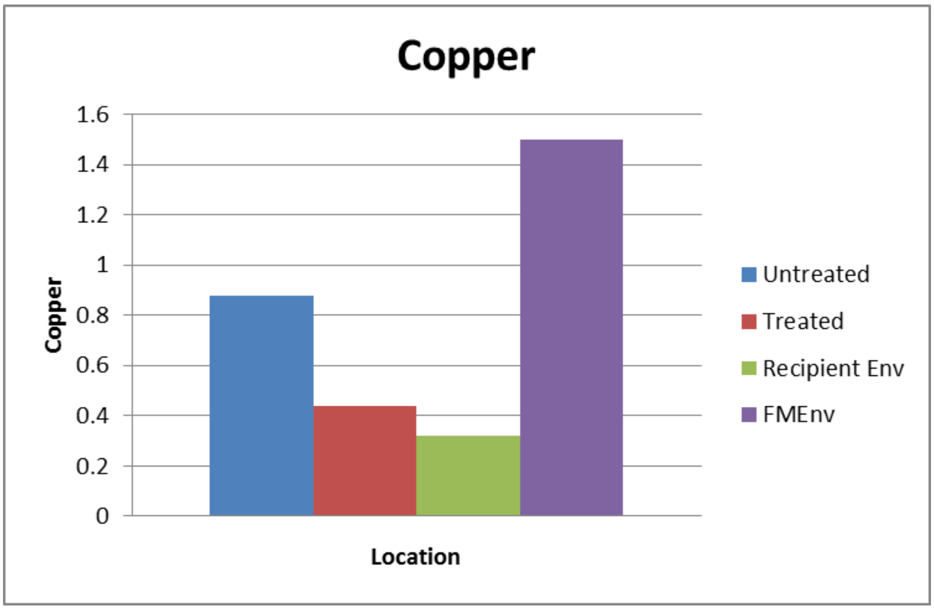

Figure 17: Comparison of copper samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment

Figure 17 indicates that the copper of untreated effluent is 0.88mg/l, treated effluent is 0.44mg/l and recipient environment is 0.32mg/l. All samples conform to the permissible effluent quality limit of federal ministry of environment which is 1.mg/l, which indicates that there is no pollution.

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Arsenic and Mercury:

The arsenic and mercury content of the untreated effluent, treated effluent and sample from recipient environment is less than 0.001mg/l. There is no specified permissible limit by the federal ministry of environment. However, the arsenic and mercury level of the samples indicate that they pose no pollution threat.

Total Coliform:

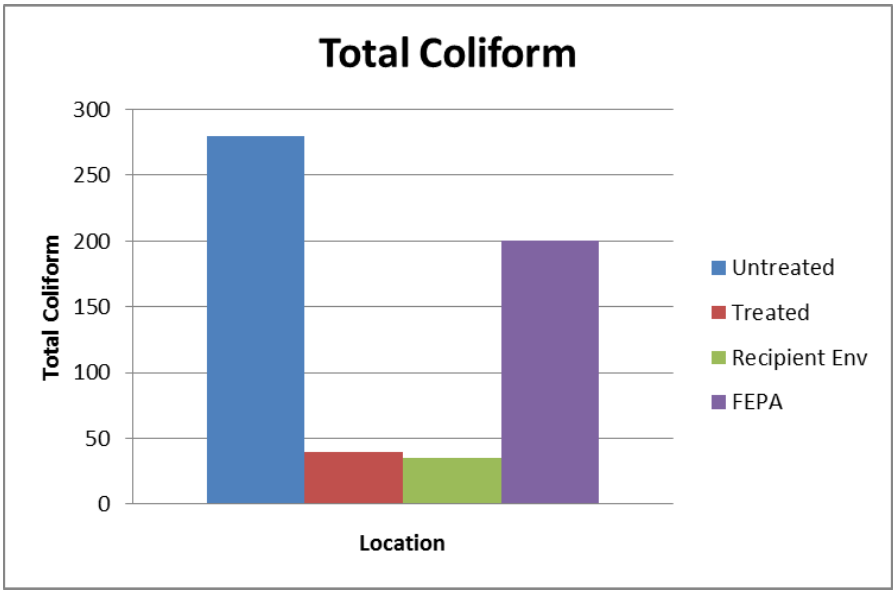

Figure 19: Comparison of total coliforms samples of untreated effluent, treated effluent, recipient environment with federal ministry of environment

Figure 19 indicates that the total coliform of untreated effluent is 280MPN/100ml, treated effluent is 39.45 MPN/100ml and recipient environment is 35 MPN/100ml. The total coliform content of the untreated effluent exceeded the effluent quality limit of federal ministry of environment which is an indication of pollution and could lead to pathogenic water related diseases which may be faecal oral, water based, water washed diseases and eater related insect vector disease if not properly treated.

4. CONCLUSION

The study indicates that the untreated sewage if discharged to the recipient environment without prior treatment, could lead to a devastating environmental pollution in the recipient environment, since most of the physico-chemical parameters such as pH, electrical conductivity, dissolved oxygen, turbidity, BOD, COD, Iron, Total coliform analysed on the untreated sewage exceeded the effluent quality limits of FMEnv which are the national standards. Furthermore, this study also revealed that the treated effluent from the sewage treatment plant and sample from the recipient environment where within the effluent quality limit of FMEnv. Hence, the untreated sewage is effectively treated by the plant as at the time this study was carried out.

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