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## RESEARCH ARTICLE

# ASSESSMENT OF DOMESTIC WATER QUALITY SUPPLIED TO HOUSEHOLDS IN THE EFFUTU MUNICIPALITY, GHANA

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**ABSTRACT**

The quality of domestic water supplied to households in the Effutu Municipality was evaluated using twenty-two physico-chemical parameters. Pearson rank correlation coefficient and an independent one-tailed student t-test were used to analyse the results. Except for colour, no significant statistical differences were observed between the samples from the headworks (HW) and the households. The correlation between the head works (Hw) and household in terms of the other parameters varied from 0.99-1.0. Generally, water samples from both the Hw and the households were potable by WHO standards. However, the presence of total coliform ranging from 10.0 cfu/100.0mL at $V_7$ (Pupils) to 489.25 cfu/100.0 mL at $V_1$ (Roman school) and faecal coliform of 0.75 cfu/100.0 mL at $V_8$ (New Winneba) to 20.50 cfu/100.0 mL at $V_4$ (Junction)in some household samples were of much concern as these levels have a high tendency to compromise the health status of consumers. Occasional breaks in pipe-lines and water rationing were found to be some of the causes of external waters infiltrating into the distribution systems. Passing pipelines through gutters and illegal connections by individuals should be discouraged by Ghana Water Company (GWC) Ltd.



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## INTRODUCTION

In its guidelines for drinking-water quality, the World Health Organization (WHO) defines domestic water as being 'water used for all usual domestic purposes including drinking, bathing and food preparation' (WHO, 1993).Domestic water supplies are one of the fundamental requirements for human life. Without water, life cannot be sustained beyond a few days and lack of access to adequate water supply leads to the spread of diseases. Children bear the greatest health burden associated with poor water and sanitation (WHO, 1993). Potable water supplied to consumers must be of highest quality and both biological and chemical contaminants should be reduced or totally eliminated (Cobbina, 2009). According to WHO, Global Health-for-All Indicators, 1996a, it is estimated that 20 litres of safe water per person per day is the amount needed to satisfy metabolic, hygienic and domestic requirements. Inability to have access to potable water may hinder sanitation and smooth livelihood in homes. Sanitation in itself is any system that promotes sanitary or healthy living conditions. It also includes systems to manage waste water, storm water, solid waste and household refuse as well as ensuring that people have safe drinking water and enough water for washing and bathing (Fadare, 2008). The quality of water in any ecosystem provides significant information about the available resources for supporting life in that ecosystem. Good quality water resources depends on a large number of physico-chemical parameters and biological characteristics (Medudhula, 2012) Although the Millennium Development Goals (MDGs) target 7(c), seeks to halve by 2015 the proportion of people without access to safe drinking water and sanitation (UNDP, 2005), it is anticipated that Sub-Saharan Africa, will only reach the MDGs water target by 2040 (Sutton, 2008). But still, some 400 million of the people living in sub-Saharan Africa will be left without access to safe water with a majority of them being women and children living in rural households (Sutton, 2008). Ghana Water Company (GWC) limited is responsible for the provision, installation, distribution and management of urban water supply in Ghana. The Winneba head works of the GWC limited in the Effutu Municipality treats water abstracted from the Ayensuriver for

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distribution in the Effutu Municipality. The head works was expanded in2001and located 6 km from the Winneba Roundabout. It supplies 7000-9000 $m^3$ of water/day to a population of about 68,592 people according to the 2,000 Population and Housing Census. ((GSS), 2014). This study evaluates the quality of treated water at the headworks compared to water supplied to the households in selected sites within the service area as part of a routine monitoring exercise.

## MATERIALS AND METHODS

### Study area

The Effutu Municipality is situated between latitudes 5 28' and 5 18' north and longitudes 0 25' and 0 40'west on the eastern part of the Central Region of Ghana (Fig.1). It is bordered to the north by the Agona Municipal, on the north-east by the West Akim Municipal, to the south by the Gulf of Guinea, to the west by the Gomoa District. The Municipality covers an area of about 417.3 $km^2$. Winneba is the administrative capital. The Municipality is generally low lying with granite rocks and isolated hills. The two major rivers; Ayensu and Gyahadze drain the Municipality and enter the sea at Warabeba and Opram respectively ((GSS), 2014). The water bodies that drain through the Municipality have the potentials to be exploited when dammed for extensive vegetable cultivation during the dry season and for aqua-culture activities. The Municipality lies within the dry-equatorial climatic zone characterized by low rainfall and long dry season of five months. The annual rainfall ranges from (400 to 500) millimetres. Mean temperatures range from 22 C to 28 C. The vegetation is that of the coastal savannah grassland which is suitable for vegetable cultivation or dry season irrigation farming. The soils in the Municipality are largely clayey with high salinity hence its suitability for salt production and pottery/roofing tiles production. The famous Aboakyer Festival of the people of the Municipality derived its existence from the annual sacrifices made to the PenkyeOtu deity (GSS, 2014)

### Sample collection

Pipe-borne water samples were collected from households at 8 sites within the Municipality and the headworks. Sampling was done once every month during a period of six months. A total of 54 samples were collected from the headworks (HW) and the households for six months. The sampling sites were Roman school ($V_1$), Souh campus ($V_2$), North campus ($V_3$), Junction($V_4$), Prisons($V_5$), Lagoon Lodge($V_6$), Pupils ($V_7$) , New Winneba ($V_8$) and the Headworks (Hw). Samples for physico-chemical analysis were collected and stored in 250.0 mL acid-washed polyethylene bottles. Micro-biological samples were put in sterilized 250.0 mL screw-neck glass bottles containing sodium thiosulphate ($Na_2S_2O_3$) to neutralize the free chlorine in water samples. Samples for metal analysis were acidified with 1.0 mL concentrated nitric acid per litre of sample. All the samples were stored at 4 C. Samples for microbial determination were analysed within 18.0 hours after sampling, while samples for physico-chemical parameters were analysed within a week (Cobbina, 2009).

All chemicals used were of analytical grade. A multifunctional HANNA meter (model HI 9032) was used to determine thepH and theconductivity *insitu*after calibration. Turbidity was determined using HACH2100AN turbidimeter. Other physico-chemical parameters such as total dissolved solids(TDS), total suspended solids(TSS), total hardness(TH), total alkalinity, colour, chloride ($Cl^-$), sulphate ($SO_4^{2-}$), phosphate($PO_4^{3-}$), Nitrite ($NO_2^-$), nitrate ($NO_3^-$), chlorine residue, total coliform and faecal coliform were analysed based on standard methods given by APHA (1995). The metals were analysed by Varian Fast Sequential Atomic Absorption Spectrophotometer after nitric acid digestion.

## RESULTS AND DISCUSSION

### Statistical Analyses

Themean values of the results obtained for each parameter was determined and compared with the HW. An independent one – tailed student t-test wasused to establish any statistical difference between the HW and the households. The level of probability at which significant difference existed between the headworks and households was set at $p<0.05$ at 95% confidence level. Pearson correlations coefficient was also used to establish correlation between the HW and the households water samples.

### pH

The pH of water supplied to the households ranged from 6.00 at $V_1$ to 7.96 at $V_3$ with a mean of 7.07 and a standard deviation of 0.74 compared to 7.28 recorded at the HW (Table 1). The pH values were within the WHO (1993) guideline value of 6.50-8.50 except $V_1$ which is slightly acidic. Correlation was high and no significant difference was observed.

### Turbidity

Turbidity of water supplied to the households in the Effutu Municipality ranged from 2.29 NTU at $V_2$ to 6.58 NTU at $V_6$ with a mean of 4.04 NTU and a standard deviation of 1.31. While the HW recorded 3.60 NTU against the WHO value of 5.0 NTU (Table 1). The correlation in turbidity between household samples and the HW was 0.99. There was no significant statistical difference in turbidity between households samples and the HW as $p= 0.50> 0.05$.

### Colour

Colour varied from 7.70Hz at $V_2$ to 27.88 Hz at $V_8$ with a mean of 19.67Hz (Table1) and standard deviation of 12.61. However, the HW recorded 47.50 Hz as against the WHO standard of 15.00 Hz. The higher value of colour at the HW suggests higher levels of total suspended solids and organic matter.

The decrease level in colour in the household samples might be due to increase deposition of suspended particles during water storage at the overhead tank before distribution.

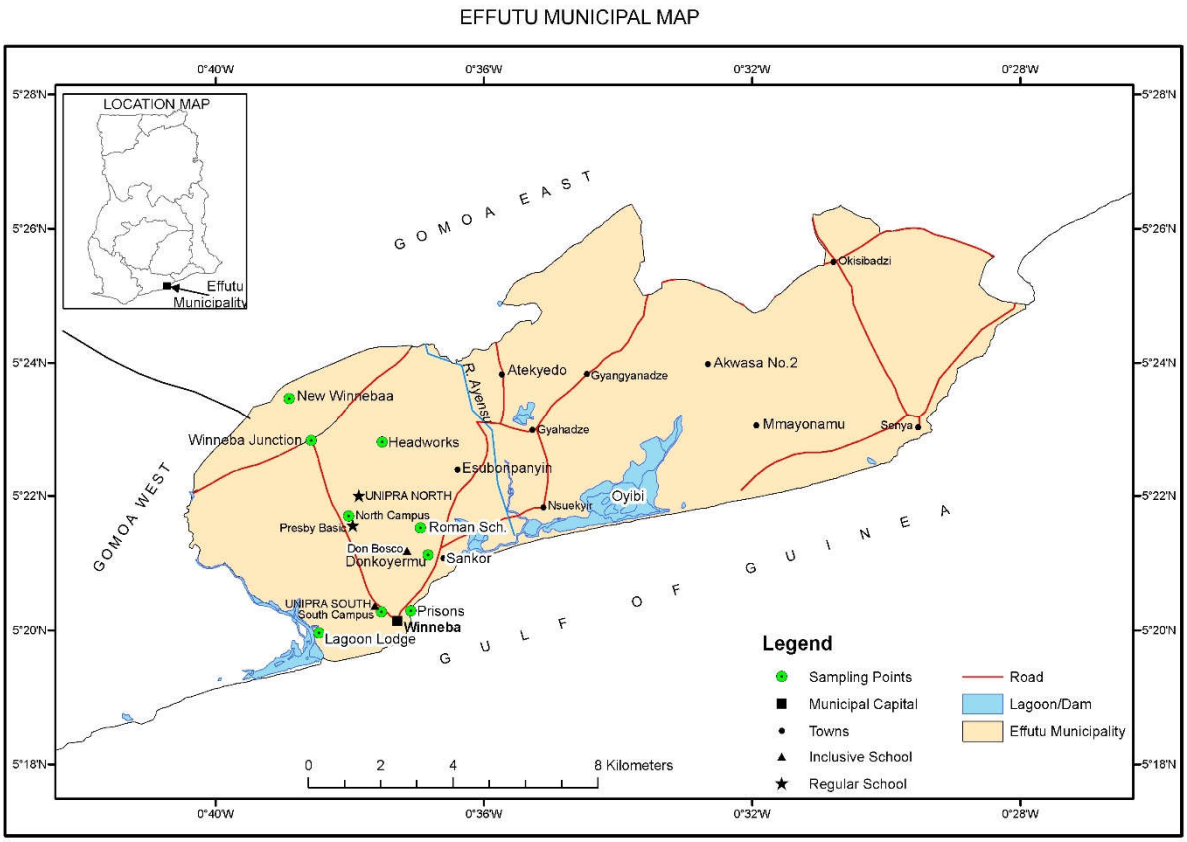


**Figure 1. Map of Effutu Municipality showing sampling points**

**Table 1. Levels of Physical parameters and major metal ions in domestic water supplied to households in the Effutu Municipality**

| | Turbidity (NTU) | Colour HZ | PH | Conductivity µS/cm | TSS mg/L | TDS mg/L | TH mg/L | Ca Hardness | Mg /mg/L | Ca mg/L | Fe mg/L | Mn mg/L | Mg mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_1$ | 3.49 | 13.70 | 6.0 | 289.20 | 2.0 | 200.80 | 58.80 | 36.38 | 22.42 | 15.03 | 0.18 | 0.03 | 7.12 |
| $V_2$ | 2.29 | 7.70 | 6.14 | 322.20 | 0.40 | 219.95 | 65.04 | 40.38 | 24.66 | 15.42 | 0.12 | 0.03 | 8.33 |
| $V_3$ | 3.65 | 9.10 | 7.96 | 338.0 | 0.25 | 220.20 | 62.04 | 39.7 | 22.34 | 15.84 | 0.16 | 0.03 | 5.35 |
| $V_4$ | 3.34 | 26.70 | 7.05 | 249.0 | 5.40 | 208.15 | 60.76 | 35.94 | 24.82 | 14.82 | 0.21 | 0.02 | 5.89 |
| $V_5$ | 5.72 | 18.30 | 7.52 | 321.2 | 2.80 | 208.15 | 57.76 | 45.86 | 11.90 | 14.73 | 0.25 | 0.03 | 5.84 |
| $V_6$ | 6.58 | 13.90 | 6.65 | 332.80 | 2.50 | 212.07 | 63.28 | 41.78 | 21.50 | 15.99 | 0.23 | 0.03 | 6.12 |
| $V_7$ | 3.50 | 12.23 | 7.73 | 383.75 | 1.25 | 208.25 | 76.0 | 47.40 | 28.60 | 19.50 | 0.26 | 0.01 | 6.22 |
| $V_8$ | 4.20 | 27.88 | 7.57 | 359.5 | 4.0 | 221.14 | 74.88 | 45.07 | 29.81 | 19.85 | 0.31 | 0.02 | 8.10 |
| Min. | 2.29 | 7.70 | 6.0 | 249.0 | 0.25 | 200.80 | 57.76 | 35.94 | 11.90 | 14.73 | 0.12 | 0.01 | 5.35 |
| Max. | 6.58 | 27.88 | 7.96 | 383.75 | 5.40 | 221.14 | 76.0 | 47.40 | 29.81 | 19.85 | 0.31 | 0.04 | 8.33 |
| Mean | 4.04 | 19.67 | 7.07 | 324.45 | 2.35 | 212.33 | 64.82 | 41.82 | 23.26 | 16.53 | 0.21 | 0.03 | 6.51 |
| Median | 3.60 | 13.9 | 7.29 | 327.50 | 2.25 | 210.16 | 62.66 | 41.78 | 24.26 | 15.84 | 0.21 | 0.03 | 6.12 |
| SD | 1.31 | 12.61 | 0.74 | 41.31 | 1.76 | 7.39 | 6.96 | 4.28 | 3.68 | 1.98 | 0.06 | 0.01 | 1.09 |
| HW | 3.60 | 47.50 | 7.28 | 271.4 | 11.20 | 172.91 | 50.93 | 43.90 | 24.30 | 17.62 | 0.18 | 0.04 | 5.59 |
| WHO(1993) | 5.0 | 15.0 | 6.5-8.5 | - | - | 1000.0 | - | - | - | 200.0 | 0.3 | 0.40 | 150 |

**Table 2. Levels ofmajor anions and bacteriological parameters in domestic water supplied to households in the Effutu Municipality**

| Sampling sites | $Cl^-$ mg/L | $SO_4^{2-}$ mg/L | $PO_4^{3-}$ mg/L | $NO_2^-$ mg/L | $NO_3^-$ mg/L | Total Alkalinity | Chlorine residue | Total coliform | Faecal coliform |
|---|---|---|---|---|---|---|---|---|---|
| $V_1$ | 55.14 | 33.22 | 0.09 | ND | 0.16 | 33.80 | 0.09 | 489.25 | 7.75 |
| $V_2$ | 57.84 | 34.92 | 0.16 | 0.01 | 0.19 | 23.00 | 0.09 | 32.50 | 7.25 |
| $V_3$ | 65.22 | 33.26 | 0.06 | 0.01 | 0.19 | 29.40 | 0.10 | 3.75 | ND |
| $V_4$ | 50.84 | 35.68 | 0.13 | 0.01 | 0.16 | 27.20 | 0.10 | 152.25 | 20.50 |
| $V_5$ | 61.84 | 33.66 | 0.11 | 0.01 | 0.20 | 27.00 | 0.10 | 16.00 | 2.75 |
| $V_6$ | 38.34 | 36.50 | 0.10 | 0.01 | 0.13 | 31.40 | 0.09 | 81.25 | 11 |
| $V_7$ | 68.28 | 38.08 | 0.11 | 0.01 | 0.22 | 31.75 | 0.08 | 10.00 | 2.75 |
| $V_8$ | 69.70 | 39.83 | 0.16 | 0.01 | 0.20 | 37.78 | 0.10 | 18.25 | 0.75 |
| Min | 38.34 | 33.22 | 0.06 | 0.01 | 0.13 | 23.00 | 0.08 | 10.0 | ND |
| Max | 69.70 | 39.83 | 0.16 | 0.01 | 0.34 | 37.78 | 0.10 | 489.25 | 20.50 |
| Mean | 56.76 | 35.51 | 0.11 | 0.01 | 0.20 | 29.50 | 0.10 | 89.25 | 5.86 |
| Median | 57.84 | 34.92 | 0.11 | 0.01 | 0.19 | 29.40 | 0.10 | 18.25 | 2.75 |
| SD | 10.89 | 2.28 | 0.03 | 0.00 | 0.06 | 4.71 | 0.02 | 157.80 | 6.71 |
| Headworks | 43.63 | 34.48 | 0.10 | ND | 0.34 | 24.20 | 0.16 | ND | ND |
| WHO (1993) | 250 | 250 | - | 1.0 | 10.0 | - | 0.2-0.5 | 0 | 0 |

**ND=** Not Detected

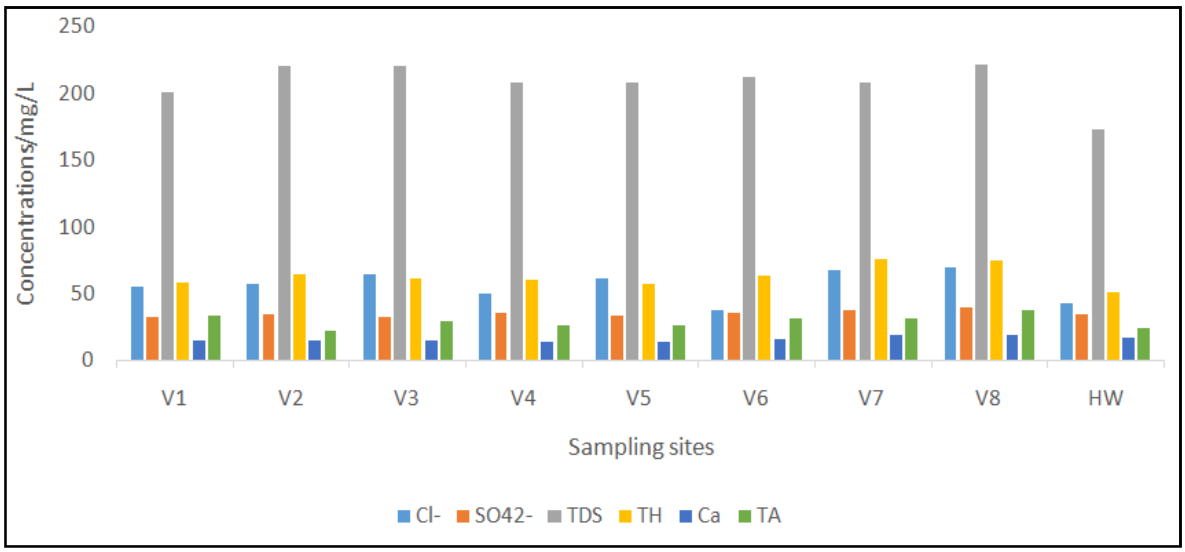


**Figure 2. Chloride, Sulphate, Total dissolved solids, Total hardness, and Total alkalinity levels in household water and HW**

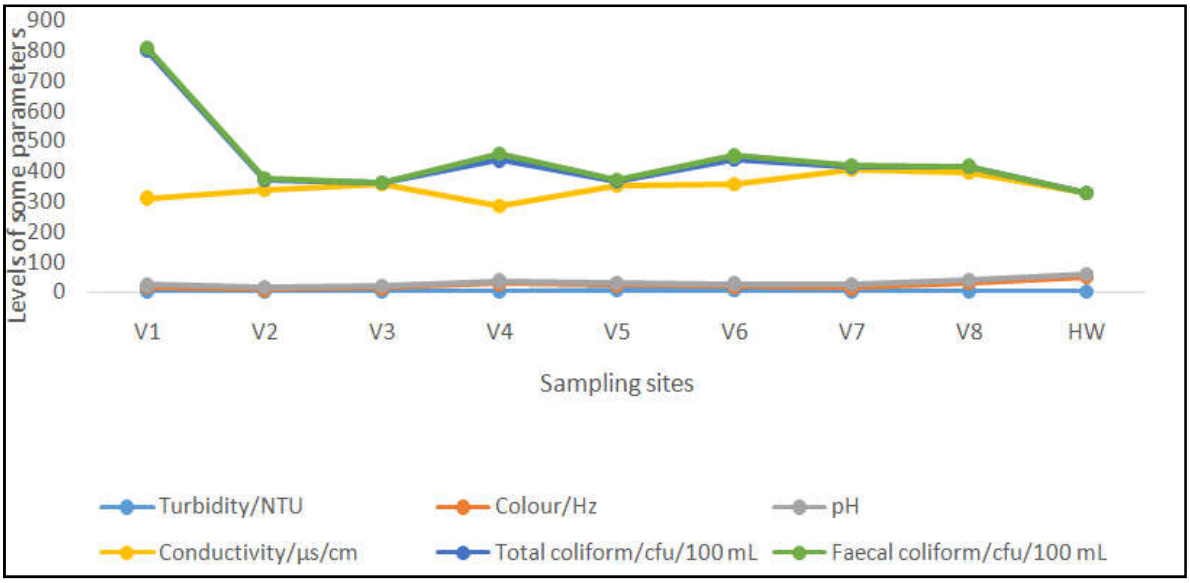


**Figure 3. Variations of Turbidity, colour, pH, Conductivity, Total coliform and Faecal coliform in household water and HW**

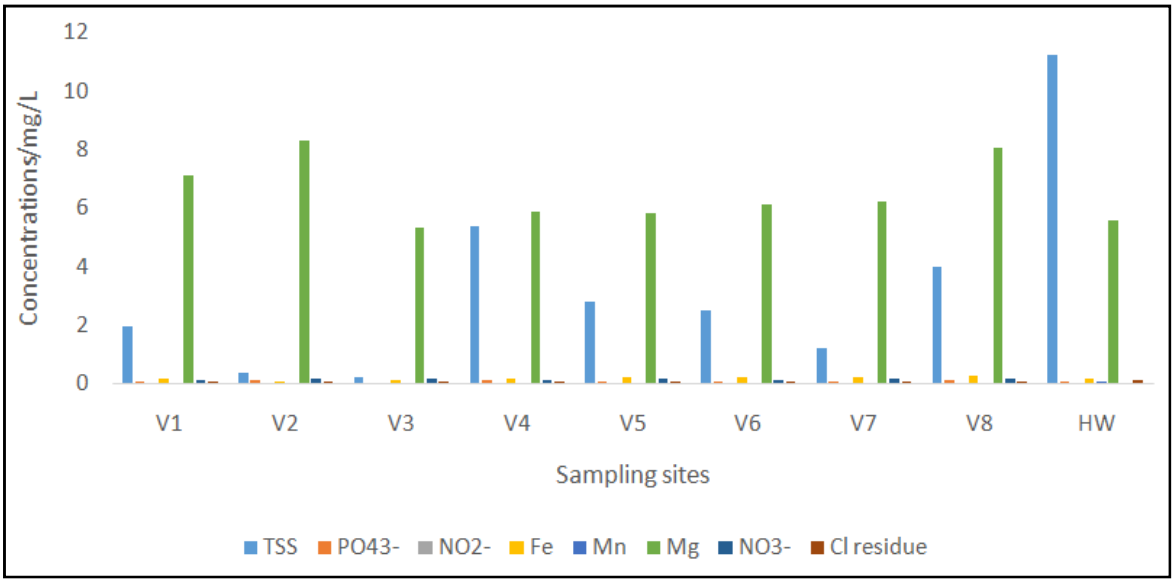


**Figure 4. Concentrations of Total suspended solids, Phosphate, Nitrite, Fe, Mn, Mg, Nitrate and Chlorine residue in household water samples and HW**

**Electrical Conductivity**

Conductivity varied from 249.0 µS/cmat ($V_4$) to 383.75 µS/cmat ($V_6$) with a mean of 324.45 µS/cm and a standard deviation of 41.31 (Table 1), while the HW recorded 271.4 µS/cm. No statistical differences was observed and correlation was high.

**Total suspended solids**

Total suspended solids (TSS) were rather high at the HW (11.20 mg/L) compared to the households which ranged from 0.25 mg/L at ($V_3$) to 5.40mg/L at ($V_4$) with a mean of 2.35 mg/L and a standard deviation of 1.76 (Table1). The higher levels of suspended solids at the HW explained the higher levels of colour observed at the HW. Pearson correlation was high and no statistical difference was observed.

**Total dissolved solids**

Total dissolved solids of both HW and the households were below the WHO value of 1000.0mg/L. It ranged from 200.8mg/L at ($V_1$) to 221.14 mg/L at ($V_8$) in the households with a mean of 2.12 mg/L and a standard deviation of 7.39. The headworks recorded 172.9 mg/L (Table 1). Statistical difference was absent and correlation was high.

**Total hardness**

There were no statistical difference between the HW and the households samples in terms of total hardness which ranged from 57.76mg/L at ($V_5$) to 76.0 mg/L at ($V_7$ ) against the WHO value of 1000 mg/L (Table1). Calcium hardness ranged from (35.94 mg/L at (V4) to 47.40 mg/L at ($V_4$) and Mg hardness(11.90 mg/L at ($V_5$) to 29.81 mg/L at ($V_8$) as againstthe HW values 50.93mg/L, 43.90mg/L and 7.03 mg/L respectively.

**Metal ions**

Fe, Ca, Mn, Mg concentrations all fell within the WHO acceptable limits of 0.3mg/L, 200.0mg/L, 0.40 mg/L and 150.0 mg/L respectively(Table1). No statistical differences were observed among these metals and the HW. Correlation was also high.

**Chloride**

Chloride ions for all samples were below WHO standard value of 250.0mg/L. The levels of chlorides in the households varied from 38.34 mg/ L at ($V_6$) to 69.70 mg/L at (V8) with a mean of 56.76 mg/L and a standard deviation of 10.89 as against the HW level of 43.63 mg/L(Table 2). Correlation was high.

**Sulphate**

Sulphate levels in the household samples also fell below WHO acceptable limit of 250.0 mg/L. It ranged from 33.22 mg/L at (V1) to 39.83 mg/L at (V8) with a mean of 35.51 mg/L and a standard deviation of 2.28 asagainst the HW level of 34.48 mg/L (Table 2).

**Phosphate**

Phosphate levels in the household samples did not differ from the HW. Nitrite and Nitrate levels fell within the WHO values. Nitrite was however not detected at the HW and $V_1$ (Table 2).

**Total alkalinity**

Total alkalinity (Table 2) varied from 23.0mg/L at $V_2$ to 37.78mg/L at $V_8$ with a mean of 29.50mg/L and a standard deviation of 4.71. Correlation was high and no statistical difference was observed between the households and the HW. Chlorine residue levels in the household samples and the HW were within the WHO acceptable limit 0.2-0.5 mg/L. It ranged from 0.08 mg/L at ($V_7$) to 0.10 mg/L at ($V_3$,$V_4$, $V_5$ and $V_8$).

**Bacteriological parameters**

No total coliform was detected at the HW. However, coliform was detected in the household samples, an indication of contamination emanating from the distribution system. Total coliform ranged from 10.0 mg L at ($V_7$) to at 489.25mg/L ($V_1$) with a mean of 89.25mg/L and standard deviation of 157.80 (Table 2).Faecal coliform was also not detected at the HW and $V_3$. Faecal coliform ranged from 0.75cfu/100.0 mL at ($V_8$) to 20.50 cfu/100.0 mL ($V_4$) against the WHO level of 0.0 cfu/100.0 mL.

**Conclusion**

Treated water supplied to households in the Effutu Municipality was generally potable by WHO standards. However, the levels of coliform and faecal coliform recorded in the household samples suggest contamination from the distribution system especially with the headworks not recording any such values. The detection of high levels of total coliform and faecal coliform however compromise the health of the consumers through water related diseases. Water distribution lines should be put on surveillance to avoid intrusion of external running waters into the distribution system. Water rationing by Ghana Water Company Ltd. should also be minimized as external waters find its way into the distribution system during the periods of water rationing (low pressure).

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## REFERENCES

(GSS), G. S. 2014. 2000 population & Housing Census, District Analytica Report- Effutu Municipality. Accra.

APHA. 1995. Standard Methods for the Examination of water and wastewater (19th ed.). Washington (DC): APHA.

Cobbina, S. J. 2009. Assessment of quality of piped water supplied to households in Western Accra. *Journal of Applied Science & Technology*, 14(1&2), 44-49.

Fadare, S. O. 2008. Domestic Water Supply and Health of Households in the Three Residential. *Ethiopian Journal of Environmental Studies and Management*, 1(2), 35-43.

Medudhula, T. S. 2012. Analysis of water Quality using Physico-chemical Parameters in lower Manair reservoir of Karimnagar District, Andhra Pradesh. *International Journal of Environmental Sciences*, 3(1), 172-180. doi:10.6088/ijes.2012030131017

Sutton, S. 2008. The Risks of Technology-based MDG indicators for rural water supply. Retrieved from www.rwsn.ch.

UNDP. 2005. Millennium Development goals. Retrieved from www.undp.org/mdg/goal 17.

WHO. 1993. Guidelines for drinking-water quality (2nd ed., Vol. 1). Geneva.

WHO. 1996a. Global Health - for- All Indicators. Retrieved from www.who.ch/hst/hsp/a/globindi.htm.

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