# Potable Water is a Serious Environmental Issue: A Special Study on Umiam Area, of Ri-Bhoi District, Meghalaya, India

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## Abstract

*Water is life. It is the foundation for health, hygiene, progress and prosperity. Therefore efficient water management is essential to civil society for the betterment of quality of life. The objective of this study to access out the supply water pollution status of Umiam area, situated in the Ri-Bhoi district of Mehgalaya; Chemical analysis of samples were carried out for tape water as it is a source of supply water, in order to assess the physico-chemical parameters like pH, TDS, alkalinity, calcium, magnesium fluorides, chlorides, fluoride, arsenic, nitrite, potassium, iron and also microbiological tests examined, all Samples were collected randomly from the tape water around Umiam area, in order to find out the water quality status around area. The values of analysed samples were compared with the guideline of international standard. Present study may be treated as a step ahead towards the drinking water quality management.*

**Keywords**: Water, umiam, total coliform, WHO.

## Introduction

Water covers 78% of the earth's surface, yet the water available for human use is limited. Water is a very essential substance for all living organisms, as it happens to be an important constituent in human body and play very important role in all metabolic process inside the body. This is the age of quality consciousness as we always insist on the quality of many things that we use or own. The quality of surface as well as ground water quality is constantly changing because of environmental degradation and anthropogenic activities which contribute in water pollution[1]. The availability of safe potable water demand will be a challenging task in near future[2]. Water quality factor is directly interrelated with the physical chemical and biological characteristics of its surrounding environment[3-4]. Safe drinking water is an important issue for human health point concern. Contamination in drinking water may lead to serious health hazards which may cause diseases viz typhoid, cholera, jaundice etc[5]. In our country, many researches are continuously going on for assessment of pollution status of water bodies[6-7] however in Meghalaya, bacteriological examination of water for drinking purposes is very limited. There is a huge water scarcity in Meghalaya especially in hilly areas as in hill area ground water level is low and insufficient to meet the supply demand with the rising population and industrialization effect. Although Meghalaya receives high rainfall every year compare to other states of India except for rainy season, water is a serious problem for almost every part of the state. The source of water is generally small streams, aquifer source, subsurface water source that generally comes out automatically from porous apertures from hillside and main source as rain water. But all these sources are also insufficient to meet the demand of huge population of the vast area. Water quality of all water sources that discussed are also not so much up to the mark in respect of portability concern. Since pure dirking water is an important environmental issue in this area, present study carries out to access the supply water quality of Umiam area (Barapani), which acts as the main source of drinking water and domestic use for local people.

## Material and Methods

The Study Area: Umiam is an industrial area of Ri-Bhoi district is located about 22km from Shillong, Meghalaya, India, famous for the Umiam Lake (Barapnai Reservoir) which is having a Hydro-electric power plant controlled by the Meghalaya Energy Corporation Limited (MeECL). This area also has some important organisations as the North Eastern Space Application Centre (NE-SAC), the North Eastern Regional institute of Educational Research (NEERI), MeECL office, SBI Umiam branch, a market complex and around 50 quarters for MeECL and other organisational official staffs. It also comprises of some major industry belt as, there is several number of Plywood, Cement, and flour mills, limestone factory, silicon factory, plastic product manufacture etc. The National Highway 40 (Guwhati-Shillong) road is passes through the Umiam area.

**Sample Collection:** Water samples were collected from different locations around the Umiam area in plastic containers of 1 litter. Various parameters Viz. pH, TDS, alkalinity, calcium, magnesium fluorides, chlorides, fluoride, arsenic, nitrite, potassium, iron and microbiological examination were

analysed as per directions and guideline given by APHA (2005).The main objective of this study to check the status of water quality, that supplied by MeCEL authority for Umiam quarter area which generally used for drinking and domestic purpose. Samples were collected randomly in month of May-June 2014. The GPS coordinate of each sampling site were mentioned in table-1.

## Results and Discussion

Results of all parameters after the test, compared with prescribed Limit of BIS and WHO for drinking water.
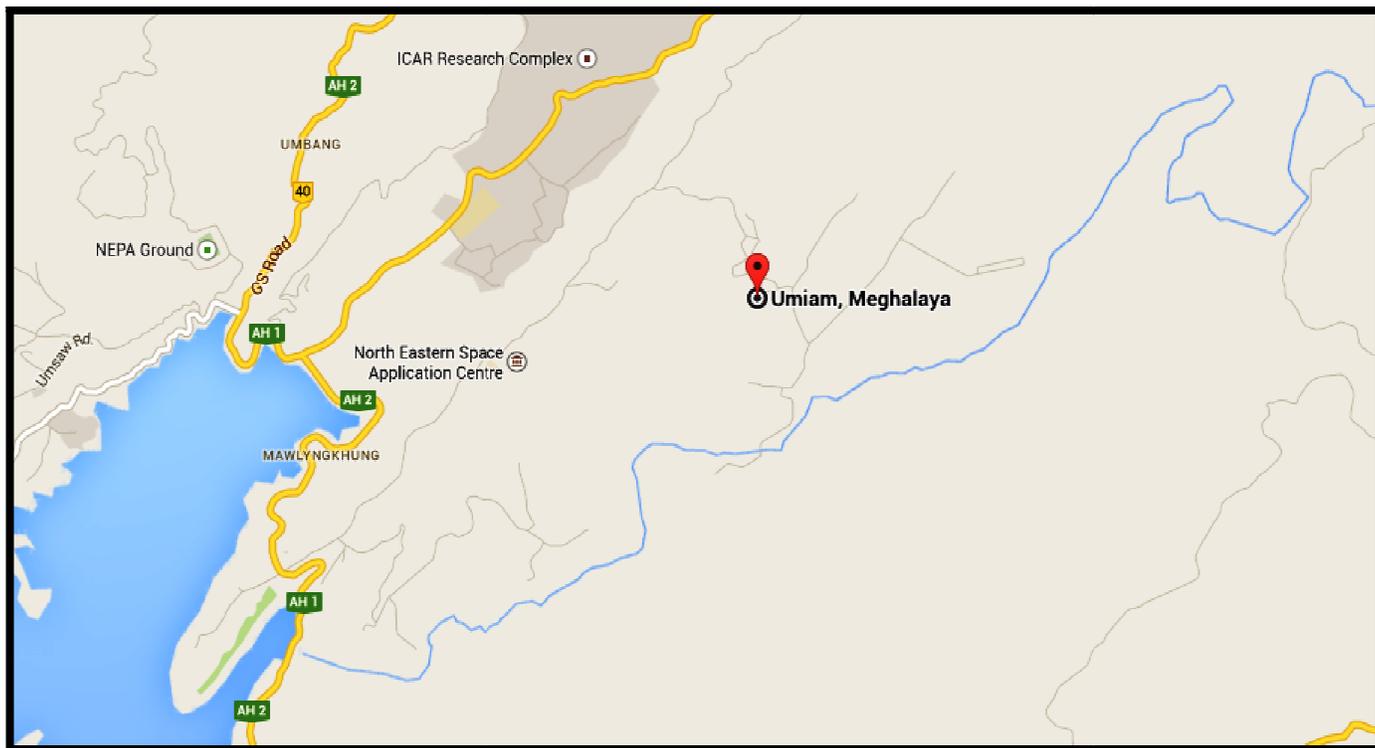


**Figure-1**
**Map of study Area**

**Table-1**
**GPS location of sampling points**

| Sample No/ID | Latitude | Longitude | Source | Location |
|---|---|---|---|---|
| Umiam 1 | 25°40'25.14"N | 91°54'39.75"E | Tape Water | Quarter Area |
| Umiam 2 | 25°40'19.95"N | 91°54'33.45"E | Tape Water | Quarter Area |
| Umiam 3 | 25°40'16.15"N | 91°54'29.80"E | Tape Water | Quarter Area |
| Umiam 4 | 25°39'54.12"N | 91°54'6.87"E | Tape Water | Quarter Area |
| Umiam 5 | 25°39'52.56"N | 91°54'14.01"E | Tape Water | Quarter Area |
| Umiam 6 | 25°40'0.44"N | 91°54'20.71"E | Tape Water | Quarter Area |
| Umiam 7 | 25°40'4.83"N | 91°54'23.89"E | Tape Water | Quarter Area |
| Umiam 8 | 25°40'9.10"N | 91°54'16.50"E | Tape Water | Quarter Area |
| Umiam 9 | 25°40'12.76"N | 25°40'12.76"N | Tape Water | Quarter Area |
| Umiam 10 | 25°40'9.51"N | 91°54'22.63"E | Tape Water | Quarter Area |

**Table-2**
**Physico-chemical and microbiological parameter of different samples**

| Parameter | Um 1 | Um2 | Um 3 | Um 4 | Um 5 | Um 6 | Um 7 | Um 8 | Um 9 | Um 10 | WHO Limit | BIS Limit | Ranges |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 7.17 | 6.84 | 6.68 | 7.1 | 7.26 | 7.31 | 7.21 | 7.05 | 6.95 | 7.15 | 7-8.5 | 6.5-8.5 | 7.072±0.1973 |
| TDS mg/l | 105 | 87 | 115 | 121 | 135 | 148 | 133 | 127 | 152 | 141 | 500 | 500 | 126.4±20.0621 |
| T A mg/l | 21 | 17 | 24 | 23 | 18 | 22 | 25 | 19 | 24 | 21 | 200 | 200 | 21.4±2.7162 |
| TH mg/l | 97 | 105 | 80 | 82 | 87 | 91 | 98 | 92 | 103 | 96 | 500 | 300 | 93.1±8.3326 |
| Chloride mg/l | 12 | 11 | 7 | 9 | 8 | 12 | 6 | 10 | 12 | 8 | 200 | 250 | 9.5±2.2236 |
| Fluoride mg/l | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.5 | 1 | 0 |
| Calcium mg/l | 34 | 29 | 33 | 31 | 26 | 28 | 32 | 35 | 33 | 34 | 75 | 75 | 31.5±2.9533 |
| Magnesium mg/l | 15 | 13 | 16 | 15 | 11 | 12 | 15 | 10 | 13 | 15 | 30 | 30 | 13.5±2.0138 |
| Nitrite mg/l | 0.003 | 0.006 | 0.004 | 0.003 | 0.007 | 0.006 | 0.007 | 0.006 | 0.002 | 0.005 | 0.02 | 0.02 | 0.0049±0.0017 |
| Iron mg/l | 0.11 | 0.1 | 0.11 | 0.1 | 0.11 | 0.09 | 0.07 | 0.08 | 0.11 | 0.1 | 0.3 | 0.3 | 0.098±0.0139 |
| Potassium mg/l | 0.6 | 0.5 | 0.7 | 0.3 | 0.6 | 0.2 | 0.4 | 0.5 | 0.2 | 0.7 | NSL | NSL | 0.47±0.1888 |
| Sulphide mg/l | 0.007 | 0.006 | 0.004 | 0.006 | 0.007 | 0.002 | 0.005 | 0.004 | 0.003 | 0.006 | 0.05 | 0.05 | 0.005±0.0016 |
| Arsenic mg/l | 0.012 | 0.008 | 0.001 | 0.009 | 0.001 | 0.008 | 0.012 | 0.008 | 0.007 | 0.006 | 0.01 | 0.01 | 0.00723±0.0037 |
| FC(MPN/100ml) | 155 | 153 | 147 | 157 | 160 | 152 | 159 | 154 | 149 | 160 | 0 | 0 | 154.6±4.5018 |
| TC(MPN/100ml) | 175 | 173 | 169 | 180 | 177 | 173 | 171 | 173 | 179 | 178 | 5 | 5 | 174.8±3.6147 |

*Note: all parameter in mg/l, except pH, and FC (Faecal Coliform), TC (Total Coliform) in ml  ND-(Not detected level).

**pH:** In the present investigation the pH values of the water sample were in range from (6.68 to 7.31). So the study indicates that results obtained were within the desirable limit prescribed by BIS and WHO (table-2). The low pH does not cause any harmful effect[8]. The results show that all the water samples were within permissible limits.

**TDS:** Total dissolved solid refers to solid matter dissolved in water. More range of TDS value denotes more suspended or dissolved solid matters in water, which decrease the portability of water quality and may cause serious health problem specially stomach related. TDS values of all locations around Umiam area ranged from 87 mg/l to 152 mg/l and all samples were within desirable range shown in table 2.

**Total Alkalinity (TA):** Strong acid neutralise capacity denotes as TA. It is the sum of hydroxides, carbonates and bicarbonates. Presence of hydroxides was not recorded in any samples of tape water of Umiam area bicarbonate was the major ion responsible for alkalinity in water. Total Alkalinity of all samples recorded as within the desirable limit prescribed by WHO and BIS.

**Total Hardness (TH):** The condition which makes water forming an insoluble curd type substance with soap and is

primary due to calcium and magnesium presence. These magnesium and calcium are key factor for total hardness in water. Total Hardness is not so much hazardous in health point of view. The acceptable limit of total hardness according to WHO and BIS is 200 mg/l. The hardness of analyzed water samples varied from 80 to 105 mg/l as CaCO$_3$. The highest value of total hardness was observed at sample no 2, as shown in Table 2. As per[9] have classified water in range of 60-120 mg/l is moderate.

**Chloride (Cl$^-$) and Fluoride (F$^-$):** The acceptable limit of chloride level in drinking water according to WHO and BIS is 200 mg/l and 250 respectively. The chloride level of analyzed water samples recorded within desirable range. The sources of fluorides are mainly, industries of iron, steel production, and petroleum refining and phosphate fertilizer. Higher concentration of fluoride causes bone and dental fluorosis. The BIS permissible limit for fluoride in groundwater is 1mg/l as given in table 2. However, in temperate region this limit is 1.5 mg/l, where, water intake is low. In present study Fluoride (F-) level concentration in all samples were in not detected range. Low Fluoride concentration may leads to dental problem for consumer.

**Calcium ($Ca^{2+}$) and Magnesium ($Mg^{2+}$):** The calcium and magnesium are the most abundant elements in the natural water they contribute to hardness of water. Both of the calcium and magnesium are inter-related. In present investigation these two parameters recorded in all samples within the desirable limit prescribed by WHO and BIS.

**Nitrite ($NO_3$) and Iron ($Fe^{2+}$):** In nature Nitrogen in ground water ultimately oxidised to nitrite. High concentration of nitrite causes Methemoglobinia (Blue baby) disease. Nitrite generally found soil and it found as $NO_3$ forms. As per the present study the concentration of nitrite and iron in all locations within desirable range prescribed by WHO and BIS.

**Potassium ($K^+$) and Sulphide**: The concentration of potassium level varied from .02 to .07. mg/l as for potassium there is no specific limit for WHO. All samples varied ranges within the

permissible limit of .05 mg/l table2. Sulphide generally found in the form of $H_2 S$. The levels of sulphide concentration in all samples were found within permissible range as shown in table 2.

**Arsenic (As):** Arsenic is a very important parameter for drinking water quality concern. As arsenic is more carcinogenic and causes cancer. In ground water generally arsenic contamination is found and it has become a global environmental issue. In present study the concentration of arsenic level within the desirable limit in all samples that examined. In ground water generally arsenic contamination is found. Arsenic is more carcinogenic compare to other Physico-chemical parameters, it is very important to study the presence of arsenic in the collected sample. But the collected sample shows that the arsenic is in the permissible limit.

**Table-3**
**Correlation of different parameter**

| pH | TD | TA | TH | Cl | Ca | Mg | Nitrite | Iron | Potassium | Sulphide | Arsenic | FC | TC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.48 | -0.06 | 0.04 | .07 | -0.31 | -0.29 | 0.36 | -0.34 | -0.26 | 0.13 | 0.34 | 0.70 | 0.33 |
| | 1.00 | 0.43 | -0.08 | -0.05 | -0.02 | -0.24 | 0.00 | -0.16 | -0.42 | -0.52 | -0.15 | 0.10 | 0.33 |
| | | 1.00 | -0.20 | -0.28 | 0.36 | 0.61 | -0.42 | -0.15 | -0.34 | -0.43 | 0.21 | -0.26 | -0.08 |
| | | | 1.00 | 0.43 | 0.12 | -0.14 | 0.03 | -0.05 | -0.20 | .00 | 0.49 | 0.03 | 0.08 |
| | | | | 1.00 | -0.03 | -0.36 | -0.40 | 0.29 | -0.46 | -0.26 | 0.31 | -0.40 | 0.28 |
| | | | | | 1.00 | 0.35 | -0.47 | -0.13 | 0.23 | -0.09 | 0.34 | -0.19 | -0.06 |
| | | | | | | 1.00 | -0.45 | 0.20 | 0.25 | 0.23 | 0.17 | -0.05 | -0.08 |
| | | | | | | | 1.00 | -0.59 | 0.19 | 0.07 | -0.12 | 0.46 | -0.45 |
| | | | | | | | | 1.00 | 0.27 | 0.28 | -0.51 | -0.30 | 0.39 |
| | | | | | | | | | 1.00 | 0.59 | -0.40 | 0.22 | -0.27 |
| | | | | | | | | | | 1.00 | 0.03 | 0.65 | 0.29 |
| | | | | | | | | | | | 1.00 | 0.19 | 0.03 |
| | | | | | | | | | | | | 1.00 | 0.37 |
| | | | | | | | | | | | | | 1.00 |

**Table-4**
**Relation of other parameters with pH**

| Dependent Variable | Independent Variable | Correlation | Reg. Coeff | Standard Error |
|---|---|---|---|---|
| pH | TDS mg/l | 0.197823779 | 0.004701855 | 0.183806285 |
| pH | TA mg/l | 0.017806122 | 0.208899151 | -0.004337349 |
| pH | TH mg/l | 0.035007995 | 0.209144272 | 0.000828933 |
| pH | Chloride mg/l | 0.065847014 | 0.208818372 | 0.005842697 |
| pH | Calcium mg/l | -0.312717194 | 0.198776753 | -0.02089172 |
| pH | Magnesium mg/l | -0.290823601 | 0.200227097 | -0.028493151 |
| pH | Nitrite mg/l | 0.358888815 | 0.195330879 | 39.51557093 |
| pH | Iron mg/l | -0.336660904 | 0.197056464 | -4.75 |
| pH | Potassium mg/l | -0.26359823 | 0.201871115 | -0.275389408 |
| pH | Sulphide mg/l | 0.129217304 | 0.207518072 | 15 |
| pH | Arsenic mg/l | 0.338452922 | 0.19692198 | 17.84996943 |
| pH | FC(MPN/100ml) | 0.697764442 | 0.149907638 | 0.03058114 |
| pH | TC(MPN/100ml) | 0.326223887 | 0.197823779 | 0.017806122 |

**Bacteriological Examination:** Microbial analysis of water is to check the presence of different groups of microorganisms present in water. This can be done by various techniques of biological examinations. One of the most widely used techniques for checking the total coliform bacteria is the (Most Probable Number) MPN technique. In present study it was recorded that, the presence of TC (Total Coliform) and FC (Faecal Coliform) in all samples were recorded very high range, that indicates the water is not suitable for drinking purpose and may leads to serious health problem for consumers. As Hazen, who studied drinking water and diarrhoeal disease due to Coli form reported that prevention of faecal contamination prevents water born diseases[10]. In all samples of Umiam area found as high range of Escherichia coli contamination as the range of 147ml to 160 ml for FC and 169 ml to 180 ml in per 100 ml as shown in figure 2. As per WHO and BIS guideline for drinking water quality, the acceptable range for TC and FC, are 5 ml and 0 ml respectively, by this study it can be concluded that sewage contamination must be there in the water supply system.

**Correlation Analysis:** From the below table it can be observed that pH has high correlation (considering abs (0.3) as cut-off value) with 7 out 14 variables. The individual relationship with each of these variables is shown in table 4. The correlation coefficient measures the degree of linear relationship between two variables. High values of regression coefficients and the multiple R-square values are the characteristics of better fit.

## Conclusion

In this study characterization of the physiochemical parameters and Microbiological examination of tape water that was performed from the ten different samples at different locations in Umiam area, the main objective was to determine the standard of supply water quality around the area. The concentration of various parameters especially as TC (Total Coliform) and FC (Faecal Coliform) were reported very high in level as per the desirable limit of WHO and BIS. All water samples of Umiam area were recorded having a very high range of TC and FC. Presence of high level of Escherichia coli presence can lead to dangerous health problem for consumers. Presence of fluoride concentration level in the samples however, was not in range of detected level in all the samples of Umiam area. As fluoride concentration level in drinking water is an important factor for dental health concern. The authors' suggestion to readers is that they should prefer boiled water for drinking and the administration should take improved water treatment process for supply.

## Acknowledgement
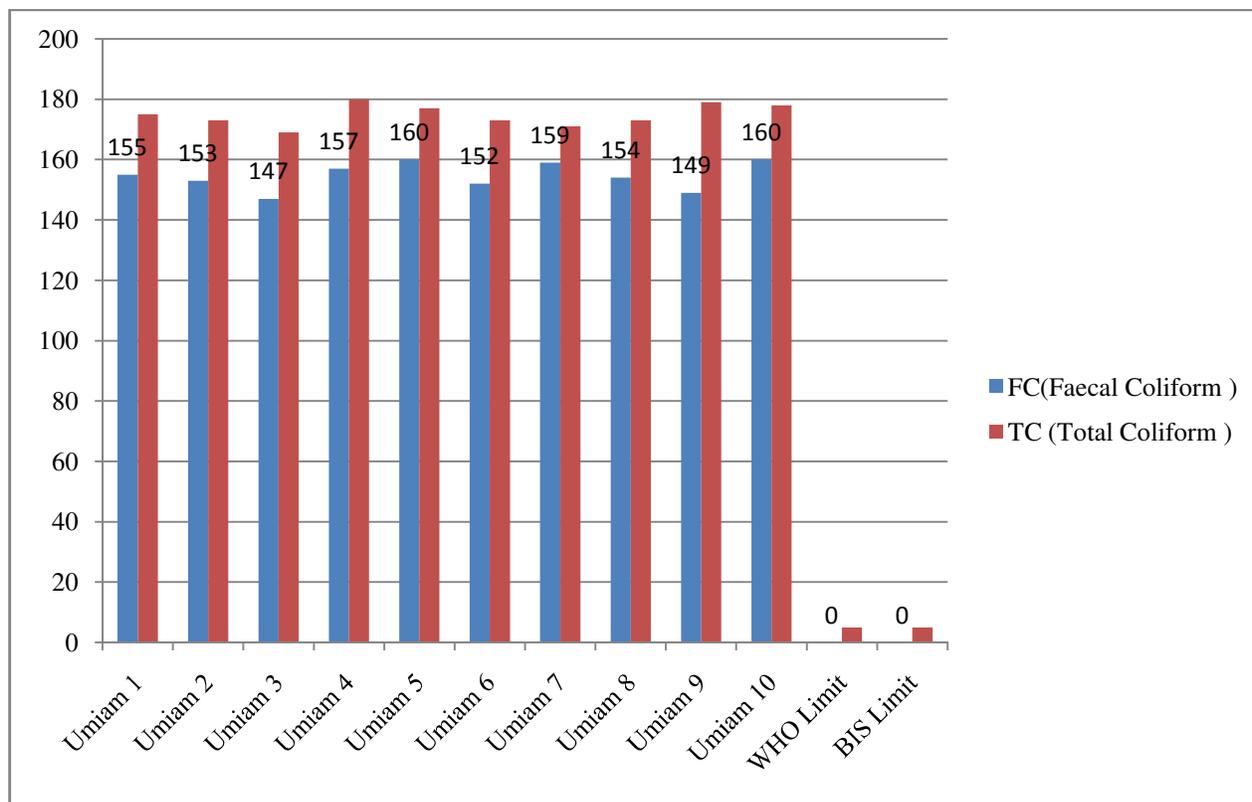
**Figure-2**
**A Graphic Representation of FC (Faecal Coliform) and TC (Total Coliform)**

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