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# The Microbial Pollution of Shallow Ground Water Strata due to Seepage of Sewage and Waste Water Discharge.

**Ather Hussain [1], M.I. Khan [1],S.M.Iqbal [2] , Mohd. Imran[3] , M.A.Mallick[4] , Manzar Alam [5].**

*1.Department of Mechanical Engineering, Integral University, Lucknow, India- 226066,*
*2.Professor & Chief Academic Consultant, Integral University, Lucknow, India- 226066,*
*3.Department of Microbiology, Integral University, Lucknow, India- 226066,*
*4.Department of Electrical & Electronics Engineering, Integral University, Lucknow, India- 226066,*
*5.Department of Microbiology, Integral University, Lucknow, India- 226066*

## ABSTRACT

The ground water is one of the major component to be environmentally protected. It is still neglected to some extent and is not given much consideration in the existing environment protection legislation in most of the developing nations. An important issue for the benefit of society is to find out the extent of impurity of water due to the pathogenic infections in the potable upper level ground water resource which is being consumed by the millions of habitants in the wide Himalayan foothill (plains) region of India. The region consists of alluvial flood effected plains with water table at shallow depth. This research paper pertains to investigation of pathogenic infections in potable first level water table at shallow depths. The samples were collected from the hand pumps of critically located village clusters in the region and tested during the pre-monsoon, monsoon and post-monsoon seasons of the year- 2011-2012. The tests for few common bacteria have been performed, e.g. - *E. coli*, *S. aureus*, *P. aeruginosa* and *S. typhie.* The results found are positive Research Highlight; A wide scope for further research does exist for the societal issue, by investigating complete range of pathogens in the similar geological structure/topography existing anywhere in world to solve health related problems. Also to check suffering and mortality due to water borne diseases and measures to protect and isolate the ground water pollution..

**Keywords** Ground Water, Surface Water Level, Potable Water, Ground Water Pollution, Pathogens and Bacteria.

*Corresponding Author Email: atherhussain48@hotmail.com
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## INTRODUCTION

The ground water(GW) is an integral part of environment and there has been inadequate attention to the health hazard in the areas where ground water is at shallow depth with special reference to northern alluvial plains of India and applicable to similar geological formation worldwide. The theme of this research work pertains to health hazard of inhabitants in a vast area due to contamination of water by bacterial seepage & harmful chemicals from surface ponds, drains, septic tanks & soak-pits into the shallow ground water aquifer, resulting in water borne diseases and mortality rate. Human excreta contains entero virus that causes viral encephalitis among 45% children in eastern parts of northern Indian alluvial plains. The report from these areas indicates, as of now, 6-7% cases of Japanese Encephalitis, which is vaccine preventive and about 45% among the patients have suffered from entero-viral encephalitis, and about

2% reported cases have a non-viral cause, such as malaria & tuberculosis. These areas are Tarai Region of Himalayan foothill alluvial plains. The actual cause of the epidemic in the area is still unknown but there are indications that it may be a water borne disease. The water is being drawn in the area from shallow depths below 30 feet by a cheap cast iron made hand pump which is not only cheap, but is easy to install any where in the region, as the water table is at 10-15 feet depth. This strata is assumed to be free from bacterial infection due to the permeability barrier of soil. In natural process flow of sub-surface contaminants to ground water table is not possible unless an un-natural conduit exist, either due to some natural phenomenon or a man made device, like the pipe connecting strainer to surface of a hand pump or casing of a tube well. Thus by providing a concealed system of water drawing mechanism, (which is not in practice), the water drawn below the water table may otherwise be safe and free from bacterial infection. The most commonly known water related diseases from a surface source are Cholera, Hepatitis, Round worm infection, Hook worm infection, Trachoma, Guinea worm, Schistosomiasis, Leishmaniasis Limphatic Filariasis, Florosis, Blue babies, and probability of latest reported cases of encephalitis.

**Importance**

The aim of investigation is to search possible occurrence of bacterial infection in potable first level ground water (at shallow depths) that may be the cause of commonly occurring viral and epidemic diseases in the flood zones of alluvial planes of north Himalayan foothills of India.

## MATERIALS AND METHODS

The review of past researches relating to occurrence of pathogens/ bacteria in the underground water has been used in this study. The other research studies have been reviewed on the subject

matter. Substantial literatures have been studied on dynamic bacterial growth model for water distribution system and methods to remove contaminants and disinfectents. A sequence of review is systematized with previous researches for subsequent studies, including current research work. The review is detailed as under:

(Rasheed, F. et.al.,2009), that the clean drinking water is not available to most of the population of Pakistan. The main source of drinking water in Hazara ($33^0$ 59'17"E; $72^0$57'18"E) , is underground and spring water. Due to earthquake water reservoirs were immensely contaminated. The study of 112 water samples which were collected and analyzed by membrane filtration method. *microbial* isolates were identified using QTS-10 and biochemical tests. Almost all samples were found contaminated. The results revealed the detection of bacterial pathogens including *Salmonella, Pseudomonas aeruginosa, Escherichia coli, Shingella dysenteriae, Staphylococcus aureus*. The authors suggested to local authorities to treat water before supply, to avoid epidemics of infectious diseases.

(Patra, A.K. et.al., 2009), the author has found out bacterial population in coastal water of Orissa, India, upto 10 km from shoreline along 6 transects were observed during 2005-06 and 2006-07. Total viable counts(TVC), total coliforms(TC), *faecal coliforms*(FC) etc. *E.coli, Shnigella, Salmonella* etc. as well as physico-chemical parameters are determined. The bacterial population was higher in Mahanadi, Paradip and Puri ($19^0$29'N-$85^0$29'E) transects as compared to other transects. The higher microbial population was recorded in stations close to shore than offshore. The bacterial population showed positive relationship with BOD.

(Ather Hussain, et.al. 2013), The bacterial transport to ground water aquifer by recharging through Rain Water Harvesting has been investigated in this paper.

(The (*Indian Standard Specifications for Drinking Water, IS: 10500),* The specification directs desirable limits of different parameters, tolerance limits, desirable characteristics of drinking water. (The (American Ground Water Trust – Bacteria and Water Wells), related to micro-organism in ground water, well protection strategies and treatment techniques have been studied for application in checking of bacterial growth in under ground water.

The research work done by Prof. KP.Kushwaha(2012), Head of Pediatric Department, Medical College, Gorakhpur ($29.4500^0$ N, $75.6667^0$ E), India, suggested that the entero virus is a large family divided into four, namely: echo, coxsackie-B, polio and human entero virus(HEV). The fatal disease that is responsible for epidemic deaths of inhabitants particularly to children in Gorakhpur and adjoining district of eastern U.P., India. Although it is still not confirmed, and it is suggestive to be a water borne disease. The further study on viral epidemic by the Pediatric &

Microbiology Departs of B.R.D. Medical College, Gorakhpur in collaboration with Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow ($26^0$51'0"N and $80^0$55'0"E), (India), and the defense laboratory at Gwalior (26.2200$^0$ N, 78.1800$^0$ E), they have concluded with the result that the HEV-76 and HEV-89 were found in majority of the samples collected from the patients of entero virus, causing encephalitis by water borne virus", (which is other than Japanese encephalitis , ensured negative after conducting Elisa test on the patients). Their research work is thus limited to clinical studies & not on the subject matter of the source study, i.e. the probability of water borne epidemic. The record shows that the research on ground water pollution has been done only in the following fields :

(i) For chemical pollutants (Arsenic finding by the Geological Survey Of India in Lakhimpur-$27^0$ 57'N-$80^0$46'E ; Bahraich- $27^0$35'N-$81^0$36'E, and in the Gangetic basin of Bihar, Bengal and Uttar Predesh states of India.

(ii) The department of water "Central Ground Water Board", Northern Region Head Quarter, Ali Ganj, Lucknow (India). The test for microbes/pathogens have not been done, except chemical elements & compound like Arsenic, fluoride etc.

(iii) The department of state water supply "Jal Nigam", Lucknow (India). The chemical test for mineral contents are being done for deep water bore wells

**Description of Study Area:**

Area of research work & collection of samples; KaiserGanj ($27^0$14'6" N-$81^0$32'42" E), District-Bahraich, India. Population of Bahraich as on 09,02.2011- 3,478,257, (Source: Registrar Census commission of India). Villages-Pyarepur (Population 9,450) . Total area covered : 6 km x 2 km = 12 Sq. Km. Number of Sampling Stations; 9 +1=10.

(a) Set of samples for pre-monsoon water condition, (b) Set of samples for the period during monsoons, (c) Set of samples for post-monsoon condition.

Sanitation system and source of pollution to underground water source **:**

**Figure 1: Soak pit for collection of domestic discharge of a group of houses through open gutters. Causing seepage at shallow depths.**

**Figure. 2 Hand Pump installed very close to soak pit.**

**Figure 3 Open gutter with rubbish, connecting houses to soak pit inflow.**

**Figure 4 The damaged soak pit structure allowing direct infectious materials to subsurface strata.**

**Figure 5 The damaged soak pit structure allowing direct inflow of infectious materials to subsurface strata.**

**Figure. 6 : Rubbish and discharge in proximity to gutter.**

**Figure 7: The proximity with the soak pits, a short circuit to flow of water in hand pump aquifer system.**

**Figure. 8: A septic tank discharge is allowed to flow in soak pit system.**

**Figure. 9: Sampling station.**

**Experimental and Objective :**

**Objective of research, importance and aim**

The aim of investigation is to search possible occurrence of bacterial infection in potable first level ground water (at shallow depths) in the flood zones of Tarai regions of northern Indian planes. It is a Societal issue and the aim is to carry out investigation for Bio-infections in the surface water level (SWL) due to first aquifer of ground water resource. The selective isolation and identification of bacterial pathogens for investigation are the Escherichia coli ( *E. Coli)*, which is the root cause for diseases like- Gut disease, Sepsis, wound infections, intestinal infection, watery diarrhea (mainly infant diarrhea). The Staphylococcus aureus (*S. aureus)* is the basic cause for diseases such as pyogenic infections, skin disease, toxicoses etc. The Pseudomonas aeruginosa (*P.aeruginosa)*, for nosocomial infections and skin diseases. The Salmonella typhi **(***S. typhie)*, are the pathogens responsible for profuse water diarrhea, acute diarrhea with vomiting, typhoid.

**Sampling method*:***

Water samples have been collected from the hand pumps at different stations as described above.

Number of sample collected**:** Twenty seven samples had been collected and tested for Bio-tests for the three seasons of the year- 2011- 2012, as shown in (Table 2). These samples have been tested in the Microbiology department of Integral University, Lucknow (India).

**Result of First set of Observation*:***

Station – 1, Set – A, Sample – 1:

Location: Village; Mohri, Tehsil ; Qaiser Ganj, Bahraich (U.P.) India

Strategy ; Soak pit- 28 mts. From the sample source(hand pump). Pond-70 mts.Agricultural fields- All around. Date of Sample Collection ; 04.08.2011,

Date of Testing ; 05.08.2011.

**Table 1 : Set – A**

| SampleNo | Total number of Isolates% | E.Coli % | S.Aureus % | P.Aerginosa % | S.Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-1- A | 100 | 50 | 0 | 0 | 50 |
| FS-H.P.-1- B | 100 | 50 | 0 | 0 | 50 |
| FS-H.P.-1- C | 100 | 75 | 0 | 0 | 25 |
| FS-H.P.-1- D | 100 | 50 | 0 | 0 | 50 |

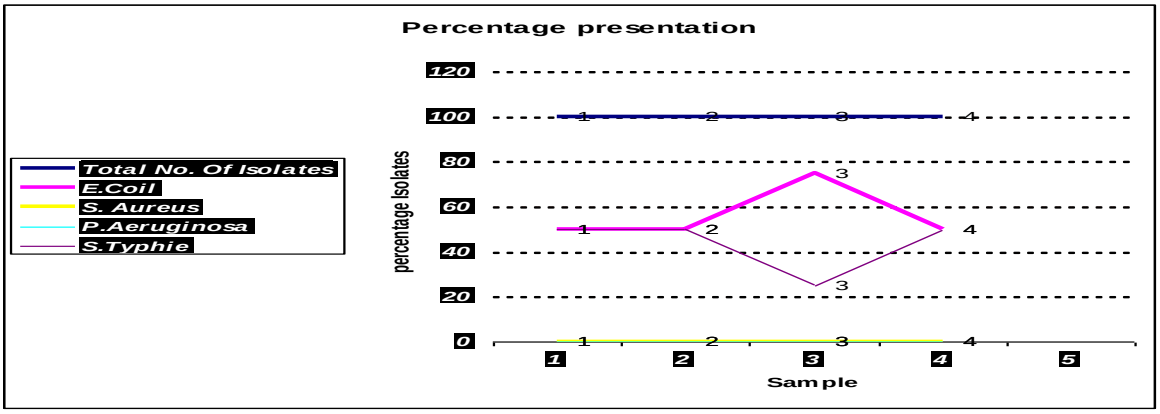


**Figure. 10 (Isolates in percent of Table-1, Set-A)**

Station – 2, Set – A, Sample – 2

Location : Village ; Pyarepur, Tehsil ; Qaiser Ganj, District – Bahraich Strategy ; Septic tank- 10 mts. From the sample source(hand pump).House drain soak pit - 04 mts. : Agricultural fields- 98 mts.,

**Table 2: Set – A**

| Sample No | Total number of Isolates% | E.Coli % | S.Aureus % | P. Aerginosa % | S.Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-2- A | 100 | 66 | 0 | 0 | 34 |
| FS-H.P.-2- B | 100 | 75 | 0 | 0 | 25 |
| FS-H.P.-2- C | 100 | 66 | 0 | 0 | 34 |
| FS-H.P.-2- D | 100 | 66 | 0 | 0 | 34 |

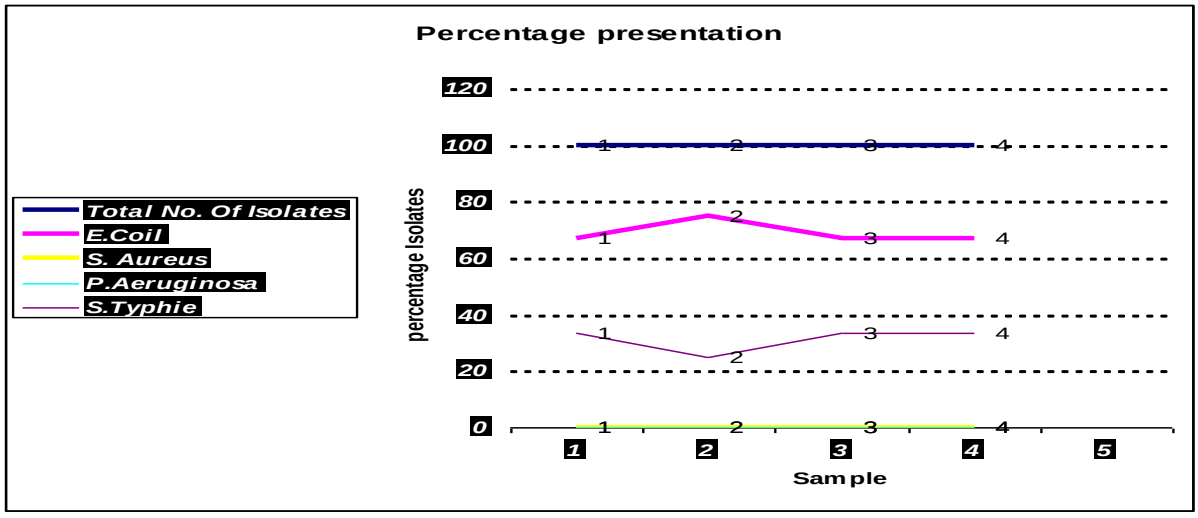


**Figure. 11 (Isolates in Percent of Table - 2, Set-A)**

Station – 3, Set – A, Sample – 3

Location : Village ; Pyarepur, Strategy ; Septic tank- 04.5 mts. From the sample source(hand pump), Drain soak pit - 03.5m. Agricultural fields

**Table 3 : Set – A**

| SampleNo | Total number of Isolates% | E.Coli % | S.Aureus % | P. Aerginosa % | S.Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-3- A | 100 | 100 | 0 | 0 | 0 |
| FS-H.P.-3- B | 100 | 100 | 0 | 0 | 0 |
| FS-H.P.-3- C | 100 | 100 | 0 | 0 | 0 |
| FS-H.P.-3- D | 100 | 100 | 0 | 0 | 0 |

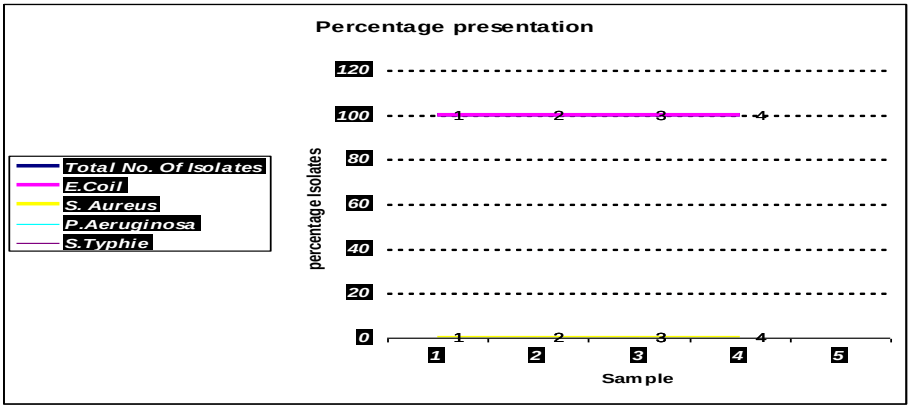


**Figure. 12 (Isolates in Percent of Table 3, Set-A).**

Station – 4, Set – A, Sample – 1 : Location: South of Village ; Pyarepur, Strategy ; Septic tank- 04.0 mts. From the sample source(hand pump). House drain soak pit - 03.0 mts., ; Agricultural fields- 150 mts.

**Table – 4, Set –A**

| Sample No | Total number of Isolates% | E.Coli % | S.Aureus % | P.Aerginosa % | S.Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-4- A | 100 | 57 | 14 | 0 | 29 |
| FS-H.P.-4- B | 100 | 66 | 17 | 0 | 17 |
| FS-H.P.-4- C | 100 | 57 | 14 | 0 | 29 |
| FS-H.P.-4- D | 100 | 57 | 14 | 0 | 29 |

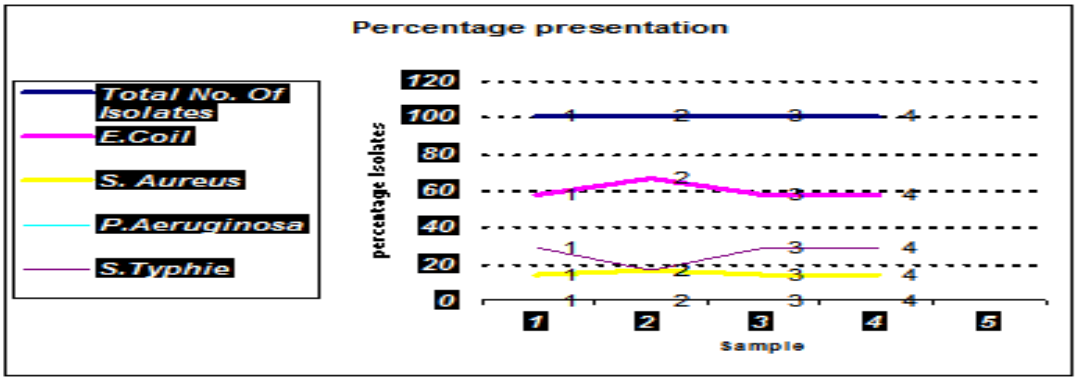


**Figure 13. Set- A**

Station – 5, Set – A, Sample – 5 :

Location : South of Village;Strategy ; Septic tank- 04.5

mts. From the sample source(hand pump), House drain soak pit - 03.5 mts. Agricultural fields - 150 mt.

**Table-5, Set- A**

| Sample No | Total number of Isolates% | E.Coli % | S. Aureus % | P. Aerginosa % | S. Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-5- A | 100 | 60 | 20 | 0 | 20 |
| FS-H.P.-5- B | 100 | 50 | 17 | 0 | 33 |
| FS-H.P.-5- C | 100 | 66 | 17 | 0 | 17 |
| FS-H.P.-5- D | 100 | 60 | 20 | 0 | 20 |

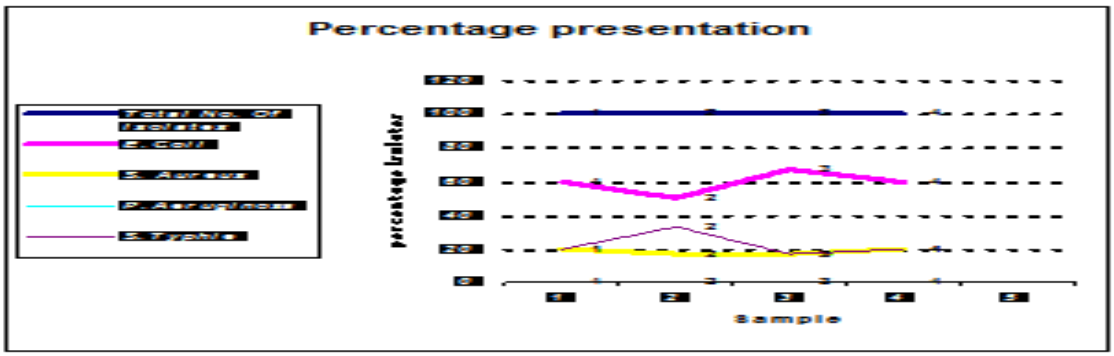


**Figure-14.Station -6, Set- A, Sample-6:**

Location: South of the Village, Strategy: House drain soak pit-03.0 mts.: Agricultural fields - 155 mts.

**Table-6, Set-A, Sample- 6**

| SampleNo | Total number of Isolates% | E. Coli % | S. Aureus % | P. Aerginosa % | S. Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-6- A | 100 | 58 | 0 | 14 | 28 |
| FS-H.P.-6- B | 100 | 72 | 0 | 14 | 14 |
| FS-H.P.-6- C | 100 | 66 | 0 | 17 | 17 |
| FS-H.P.-6- D | 100 | 58 | 0 | 14 | 28 |

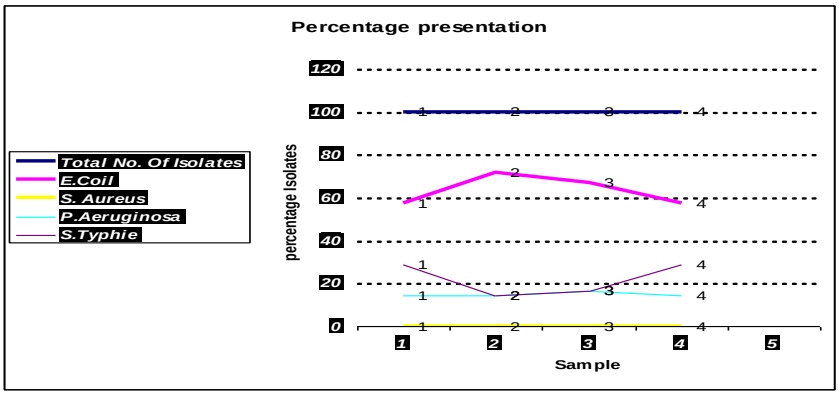


**Figure-15. Sample-6.**

Location: Station–7, Set–A, Sample–7(South of Village ; Pyarepur, Strategy ; Septic tank- 04.50 mts. from the sample source(hand pump). House drain soak pit - 04.0 mts., Agricultural fields - 185 mts.

**Table-7, Set-A, Sample-7:**

| Sample No | Total number of Isolates% | E.Coli % | S.Aureus % | P.Aerginosa % | S.Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-7- A | 100 | 50 | 0 | 0 | 50 |
| FS-H.P.-7- B | 100 | 50 | 0 | 0 | 50 |
| FS-H.P.-7- C | 100 | 67 | 0 | 0 | 33 |
| FS-H.P.-7- D | 100 | 50 | 0 | 0 | 50 |

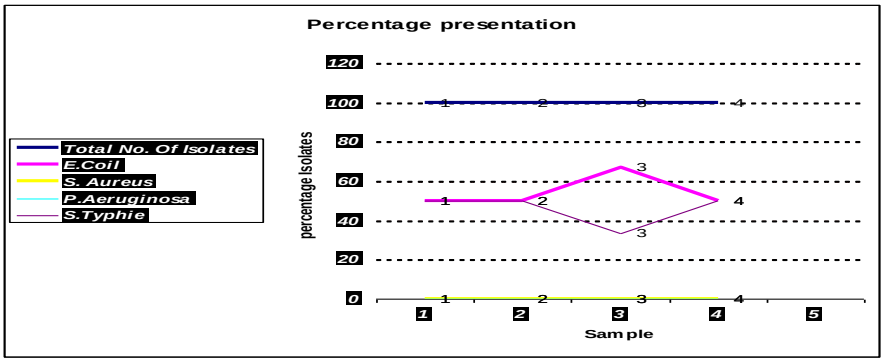


**Figure-16. Sample-7**

Location : Station–8, Set–A, Sample–8: South of Village; Pyarepur, Strategy ; Septic tank- 04.00 mt., from the sample source(hand pump) House drain soak pit–04.50 mts. Agri- fields 190 mt.

**Table- 8, Sample- 8**

| Sample No | Total number of Isolates% | E.Coli % | S.Aureus % | P.Aerginosa % | S.Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-8- A | 100 | 75 | 25 | 0 | 0 |
| FS-H.P.-8- B | 100 | 50 | 25 | 0 | 25 |
| FS-H.P.-8- C | 100 | 75 | 25 | 0 | 0 |
| FS-H.P.-8- D | 100 | 50 | 25 | 0 | 25 |

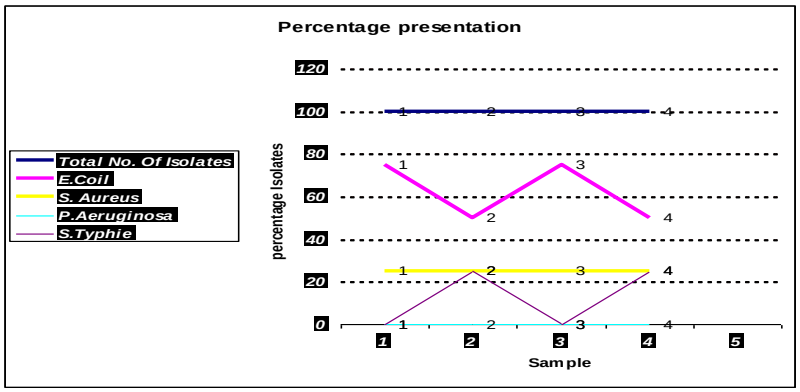


**Figure 17.Sample- 8**

Location: Station–9, Set–A, Sample–1:North of Village ; Pyarepur,.Strategy; Septic tank- 04.00 mts. from the sample source(hand pump).House drain soak pit-02.50mt. Agri- fields-400 mts.

**Table-9, Sample- 9**

| Sample No | Total number of Isolates% | E. Coli % | S. Aureus % | P. Aerginosa % | S. Typhie % |
|---|---|---|---|---|---|
| FS-H.P.-9- A | 100 | 100 | 0 | 0 | 0 |
| FS-H.P.-9- B | 100 | 100 | 0 | 0 | 0 |
| FS-H.P.-9- C | 100 | 100 | 0 | 0 | 0 |
| FS-H.P.-9- D | 100 | 100 | 0 | 0 | 0 |

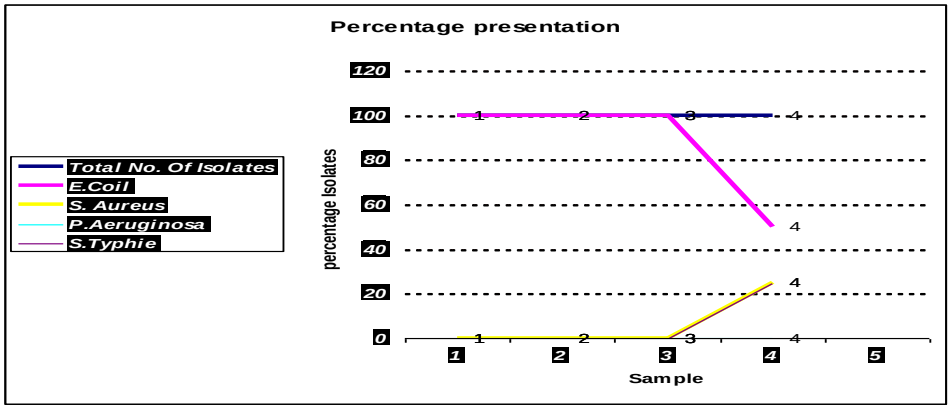


**Figure- 18. Sample- 9.**

The second set of data collected and the test report (during monsoon-2011, dated 06.10.2011): The results are similar with little variations. The third set of data collected and the test report (after monsoon-2011, dated 10.02.2012): The results are similar. The details are not shown due to space limitation and repeating similar data.

**Observation**

On the analysis of data of Set- 1(1 to 9), Set – 2 (1 to 9), Set – 3 (1 to 9) and Mohri Farm(at 7 km. distance from other stations). It is observed that, E.Coli is found in all most all the samples. The samples in Set–2 have higher concentration than in samples of Set-1. It is obvious due to seepage of infection during rains and flood.

The pathogen S.Typhie is also found in all the samples, except station- A-3, A-9,and B-6. The reason may be installation of pump at an elevated level above 5 feet from the R.L. of the village. The pathogen S. Aureus is found in samples A-4, A-5, A-8, B-6 & B-9. The pathogen P-Aerginosa is found in samples A-6, B-1, B-2, B-3, B-4, B-5, B-8.

## CONCLUSION

On the analysis and comparison of data of different sets of readings, it is confirmed that the pathogens under test are found alone or in group in almost all the water samples. The ground water

being consumed, is not fit for direct consumption. The cause of epidemic and adverse effect on health, in particular among children of the region, is a serious societal problem, inviting detailed research work in this domain.

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