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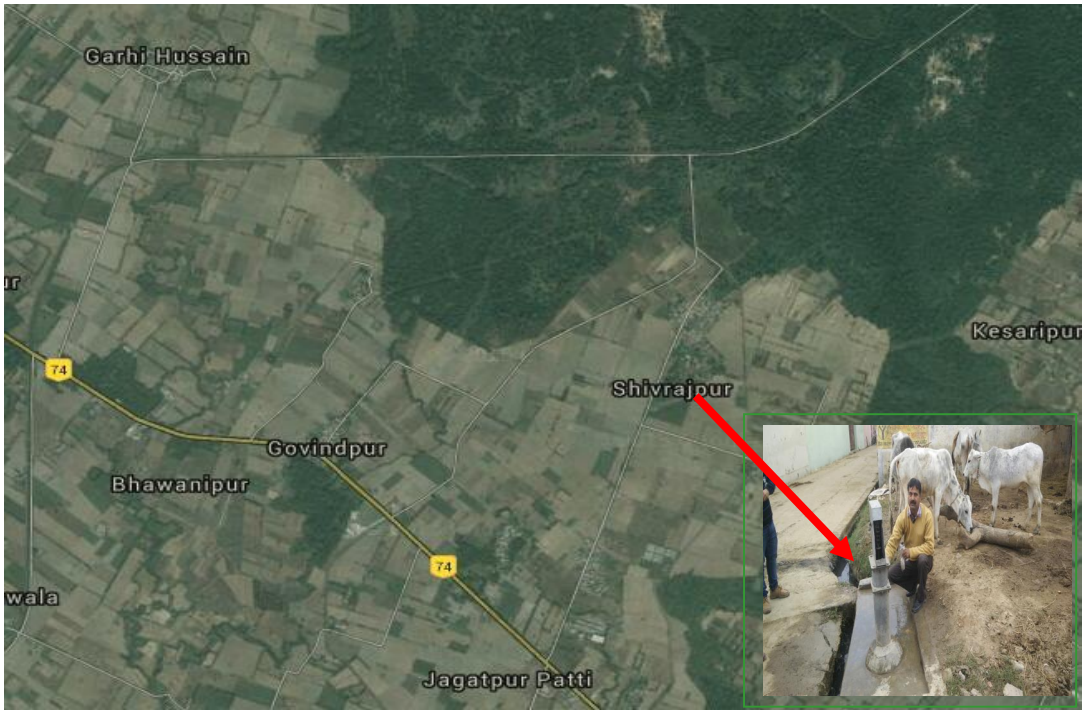
GROUND WATER QUALITY MONITORING OF VILLAGE SHIVRAJPUR, BLOCK-JASPUR, DISTT. US NAGAR, (UTTARAKHAND)



Sponsoring Agency

Uttrakhand Environment Protection & Pollution Control Board
Dehradun

Investigating Agency

Pollution Control Research Institute, BHEL, Ranipur, Haridwar – 249403

January 2016

EXECUTIVE SUMMARY

Jaspur is located at 29°17'N 78°49'E 29.28°N 78.82°. It has an average elevation of 320 metres (1050 feet). It is a small city, 45 km from Corbett National Park, Ramnagar and 210 km from New Delhi.It is 110 kms From Nainital. It is the border town of Uttarakhand.

According to Census 2011 information the location code or village code of Shivrajpur village is 055782. Shivrajpur village is located in Jaspur Block of Udham Singh Nagar district in Uttarakhand, India. Jaspur is nearest town to Shivrajpur village.

As per scope of work, it was referred that assessment of Ground Water Quality of Shivrajpur, village is required to be assessed. In view of this, the survey was made and identified 6 hand pumps in Shivrajpur village of Jaspur.

The parameters Alkalinity, Ammonia, Arsenic, Bio-chemical Oxygen Demand, Boron, Cadmium, Calcium, Chloride, Chromium Total, Chemical Oxygen Demand, Colour, Conductivity, Dissolved Oxygen, *E. coli*, Fecal Coliform, Fecal Streptococcus, Fluoride, Hardness, Iron, Lead, Magnesium, Mercury, Mineral Oil, Nickel, Nitrate, Nitrite, pH, Phosphorus, Potassium, Sodium, Sulphate, Temperature, Total Coliform, Total Dissolved Solids, Total Plate Count, Turbidity and Zinc were analysed.

The analytical results were compared with Standard of Drinking water Quality IS:10500. The summary and finding of these results with respective hand pumps are as follows:

Summary of Ground Water Monitoring Data of Identified Hand Pumps at Shivrajpur Village , Block Jaspur, Distt.U S Nagar

S.N.	Name of Sampling Location	Parameters Above	
		Standard Acceptable Value	**Maximum Permissible Value**
1.	H/o Sh. Babu Ram	Alkalinity, Turbidity	-
2.	H/o Sh. Dharamveer	Alkalinity, Turbidity	-
3.	H/o Sh. Kartar Singh	Alkalinity, Calcium, **Fecal Coliform**, Hardness, **Total Coliform**, Total Dissolved Solids, Turbidity	**Total Coliform, Fecal Coliform,** Turbidity
4.	H/o Sh. Ant Ram	Alkalinity, **Fecal Coliform**, Hardness, **Total Coliform**, Turbidity	**Total Coliform, Fecal Coliform**, Turbidity
5.	H/o Sh. Mukesh Kumar (Pradhan)	Alkalinity, Calcium, **Fecal Coliform**, Hardness, **Total Coliform**, Turbidity	**Total Coliform, Fecal Coliform**
6.	H/o Sh. Natthu Singh	Alkalinity, Calcium, ***E. coli*,**	Alkalinity, ***E. coli*, Total**

		Fecal Coliform, Hardness, Magnesium, **Total Coliform**, Total Dissolved Solids Turbidity	**Coliform, Fecal Coliform,** Turbidity

On comparing the ground water quality analysis results with IS 10500:2012, it is observed that the values of Total Coliform, Fecal Coliform and Turbidity are higher than acceptable as well as the permissible limits at all the locations except the first two. Therefore it could be concluded that Ground Water is safe for drinking and other purposes only at the first two sampling points.

In order to ensure safe Drinking Water of hand Pumps following are the recommendations for disinfection of water and installation of hand pumps :

The Hand Pump should be installed as per the following method:

Installation of the Hand pump

Construction of concrete platform (185 cm dia.) and drain to ensure discharge of waste water at least 3 meters away from the hand pump.

- Properly sloped (1:2) masonry apron should be constructed around the hand pump to prevent accumulation and percolation of dirty water just around the hand pump.
- A smooth drainage channel at least 3 metres long should be constructed from the hand pump to prevent stagnation of water around the hand pump as well as seepage into the hand pump.
- A soak pit should be constructed for disposal of spilled / waste water.

Waste water from a hand pump site can be discharged to kitchen garden, existing drains or soak pit.

Protection of Surrounding of the Hand Pump

Defecation near the hand pump site indiscriminately anywhere in the village should be stopped by common agreement and enforcement by social pressure.

Compost and garbage pits and drains should not be allowed within at least 15 meters radius of the hand pump. Garbage and compost pits should be established in the village away from the water source and their use should be encouraged rather than random waste disposal.

Laundry, bathing, watering and washing of animals should be done about 15 metres away from the hand pump. This will minimize the quantity of waste water to be disposed off from around the immediate vicinity of the pump.

Proper chlorination in all the Hand pumps is required to be done as per standard practice as per the following:

Wells should be disinfected after initial hand pump installation and subsequent repair. Disinfection techniques should be done as follows:

- In case dug well is used for drinking; the dug well water used for drinking should be free from micro-organisms occasionally by chlorinating with measured amount of bleaching powder. It has been observed that 4 mg of bleaching powder given for only one litre of dug well water very effectively destroys the micro-organisms in water and the residential chlorine remains in the range of 0.2-0.5 mg/l.
- There should be clear cut instructions for chlorination frequency at Hand Pumps.
- There should be proper storage of Bleaching powder or it would be better if liquid chlorine is used.
- Awareness about importance of water quality among villagers is required.

ACKNOWLEDGEMENT

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Our gratitude and thanks are also due to the Regional Officer, Uttrakhand Environment & Pollution Control Board, Kashipur and of respective places, where the present studies have been carried out for their associations and help in conducting these studies.

We are also thankful to all those institutions which have directly or indirectly extended their help during the collection of data related to these studies.

Investigators are thankful to BHEL Management for providing the facilities for conducting the study. Without such support it would have hardly been possible for project investigators to conduct the study smoothly and prepare this report.

REPORT CONTENTS

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1. INTRODUCTION

Water is the elixir of life for both animals and plants. Both the quality and quantity of water are important for the quality of life. Various economical and industrial activities are using this vital resource as though it will be available for eternity. It is, therefore, important to manage water resources judiciously.

There is an increase in the spurt of industries which in turn also increase the environmental pollution due to emissions and waste generated from these industries. The industrial pollution due to its nature has potential to cause irreversible reactions in the environment and hence, is posing a major threat to sustainable development. As the carrying capacity of the environment is limited and some ecosystems are more

susceptible to adverse environmental impacts than others, the unplanned and haphazard location of industries might substantially increase the risk to the environment.

The ground water study is essential for assessing the ground water quality. The observational data can be profitably utilized for taking up studies regarding behaviour of ground water table and the pattern of ground water table variations over a number of years, its relation to rainfall and irrigation and latest conditions regarding water table in the State. These studies are of vital importance from the point of view of development of water-logging. It, therefore, becomes imperative to have a careful watch over the behaviour of ground water table since rise of ground water can be permitted only to a certain extent. The study of behaviour of water table can prove of immense importance in enabling us to act judiciously.

Ground water pollution is an impairment of water quality by chemicals, heat or bacteria to a degree that does not necessarily create an actual public health hazard, but does adversely affect such waters for domestic, farming, municipal or industrial use. The pollution can originate point or distributed sources within the recharge area of an aquifer. The rise of ground water pollution is highest in urban areas where large volumes of wastes are concentrated into relatively small areas. The risk is further increased if they are located on areas of permeable surface deposits.

Further, the intensive use of natural resources and the large production of wastes in modern society often pose a threat to ground water quality and already have resulted in many incidents of ground water contamination. The ground water moves very slowly, sometimes many years may lapse after the start of pollution affected water shows up in a well. Similarly, many years may be required to rehabilitate contaminated aquifers after the sources of pollution have been eliminated. Sometimes this delay may force abandonment of wells and may require costly development of alternate water supplies. Prevention of contamination thus is the best way for protecting ground water quality. Slow movement of ground water is favourable, as radioactive substances, bacteria and viruses may decompose or die, with the passage of time. In such cases, long underground detention times may result in essential removal of the undesired substances. Degradation of ground water quality can take place over large areas from plane or diffused sources like deep percolation from intensively farmed fields or it can be caused by point sources such as septic tanks, garbage disposal sites and oil spills or

other accidental entry of pollutants into the underground environment. A third possibility is contamination by line source of poor quality water like seepage from polluted streams.

Ground water is an important component of the water system for domestic, industrial and agricultural purpose. It is commonly used source for drinking water for urban and rural sectors in India.

Today the accelerated pace of development, rapid industrialization and population density have increased demand of water resources. Ground water, a gift of nature, is about 210 billion m^3 including recharge through infiltration, seepage and evaporation. Out of this nearly one third is extracted for irrigation, industrial and domestic use, while most of the water is regenerated into rivers.

Over 98% of the fresh water on the earth lies below its surface. The remaining 2% is what we see in lakes, rivers, streams and reservoirs. Of the fresh water below the surface, about 90% satisfies the description of ground water, that is, water which occurs in saturated materials below the water table. About 2% water occurs as soil moisture in the unsaturated zone above the water table and is essential for plant growth.

Ground water acts as a reservoir by virtue of large pore space in earth materials, as a conduit which can transport water over long distances and as a mechanical filter which improves water quality by removing suspended solids and bacterial contamination. It is the source of water for wells and springs, that is, the recommended source of rural domestic use. It is replenished by precipitation through rain, snow, sleet and hail.

It is always better to protect ground water first rather than relying on technology to clean up water from a contaminated source. Ice caps and glaciers account for 76.6% of fresh water source on earth, followed by ground water 22.7% and surface water, a mere 0.5%. Despite ground water being a major source of drinking water it is often disregarded because of a lack of knowledge about its behaviour. Ground water is a principal source of drinking water, particularly in rural areas and also for irrigation, but it has earlier been polluted or overused, making it impotable or resulting in its depletion.

In terms of percentage, the pollution of ground water, is however, quite small. In cities and villages, pollution activities are high and these are affecting human health as well as the environment. Although only a small fraction of the total ground water resources are affected by human activities, but the proportion of local usable resources affected are much higher and becoming critical in some areas close to the major population centers.

Factors Affecting Ground Water Pollution : The extent of ground water pollution depends on the following factors :

1. Rain Fall Pattern,
2. Depth of Water Table,
3. Distance from the Source of Contamination, and
4. Soil Properties such as Texture, Structure and Filtration Rate.

Source of Contamination in Ground Water : Underground sources of drinking water, especially in outskirts of larger cities and villages are highly polluted. Ground water is threatened with pollution from the following sources:

1. Domestic Wastes
2. Industrial Wastes
3. Agricultural Wastes
4. Run off from Urban Areas
5. Soluble Effluents

Harmful Effects of Ground Water Pollution:

Ground water pollution causes high extent of damage to soil, plants and animals including man.

Harmful Effects on Man:

a) Polluted ground water is the major cause for the spread of epidemics and chronic diseases in man. It causes typhoid, jaundice, dysentery, diarrhoea, tuberculosis and hepatitis.
b) Water contaminated by fibres i.e. asbestos causes fatal diseases like asbestosis and lung cancer.
c) Ground water in excessive rainfall areas contains iron in toxic amounts as much as 20 mg/L. In deep tube wells, iron exists as ferrous ion which on taking out rapidly changes to light yellow orange colour due to oxidation and precipitation as ferric hydroxide.
d) The woollen industries contribute large amounts of toxic metals such as Hg, Ni, Cu, Cr, Fe, and cyanides to ground water causing skin and stomach diseases in man.

Harmful Effects on Soil:

a) The use of polluted ground water for irrigating agricultural fields severely damages crop and decreases grain production.
b) Polluted water acutely affects soil fertility by killing bacteria and soil microorganisms.
c) Contaminated ground water increases alkalinity in the soils.
d) Ground water pollution affects plant metabolism severely and disturbs the whole ecosystem.

2. OBJECTIVE OF STUDY

1. To survey of existing Hand Pumps in Village Shivrajpur to assess the overall physical condition of these hand pumps.

2. To Collect Ground Water samples of Identified Hand Pumps within the Village Shivrajpur .

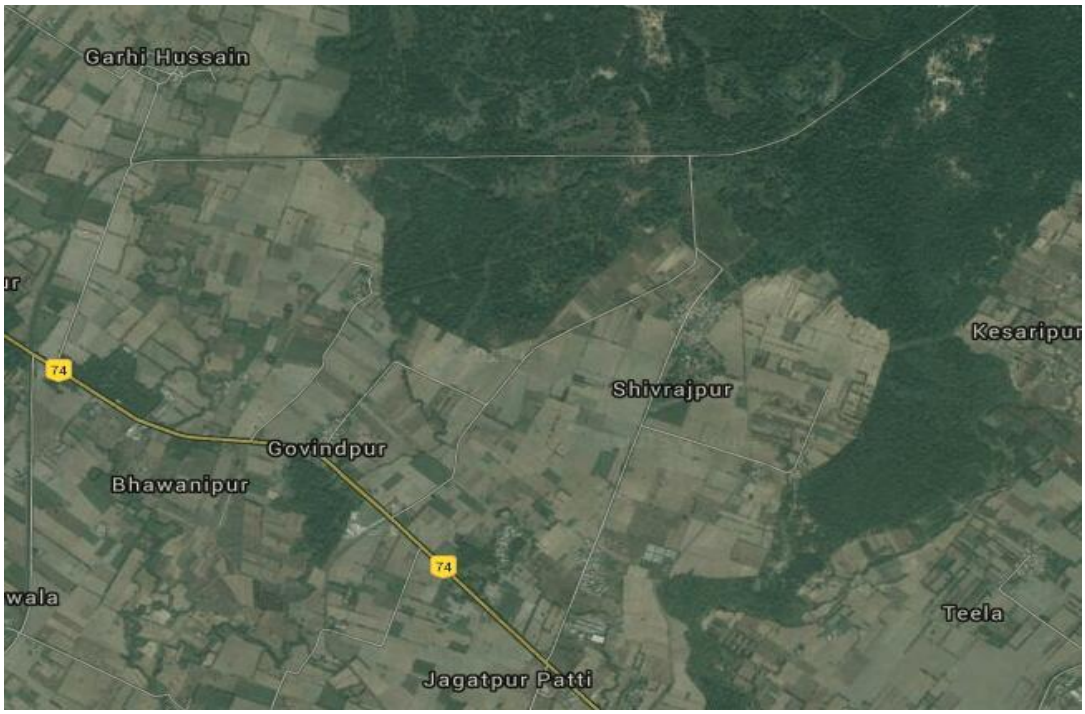
3. To analysed Alkalinity, Ammonia, Arsenic, Bio-chemical Oxygen Demand, Boron, Cadmium, Calcium, Chloride, Chromium Total, Chemical Oxygen Demand, Colour, Conductivity, Dissolved Oxygen, *E. coli*, Fecal Coliform, Fecal Streptococcus, Fluoride, Hardness, Iron, Lead, Magnesium, Mercury, Mineral Oil, Nickel, Nitrate, Nitrite, pH, Phosphorus, Potassium, Sodium, Sulphate, Temperature, Total Coliform, Total Dissolved Solids, Total Plate Count, Turbidity and Zinc .

4. To assess probable sources of ground water contamination in Village Shivrajpur, Block-Jaspur, and District Udham Singh Nagar and also identify the sources of *E.coli* in ground water.

3. GROUND WATER QUALITY ASSESSMENT METHODOLOGY

Jaspur is located at 29°17′N 78°49′E / 29.28°N 78.82°. It has an average elevation of 320 metres (1050 feet). It is a small city, 45 km from Corbett National Park, Ramnagar and 210 km from New Delhi.It is 110 kms From Nainital. It is the border town of Uttarakhand.

According to Census 2011 information the location code or village code of Shivrajpur village is 055782. Shivrajpur village is located in Jaspur Block of Udham Singh Nagar district in Uttarakhand, India. Jaspur is nearest town to Shivrajpur village.



The following methodology was adopted to carry out the study:

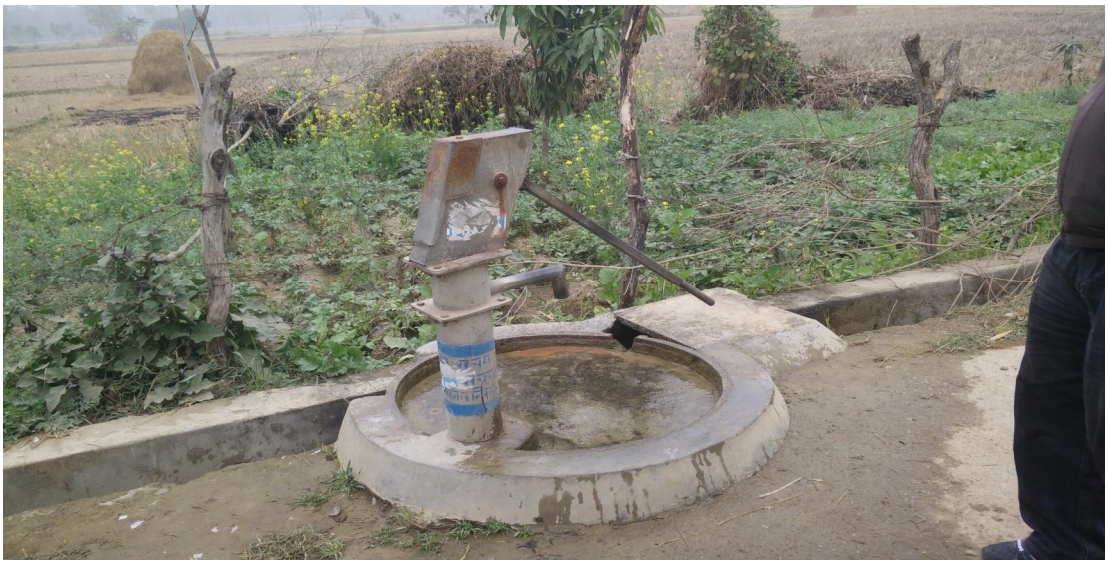
a) A survey of existing Hand Pumps in Village Shivrajpur was done in order to assess the overall physical condition of these hand pumps.
b) For the purpose of Ground Water Quality Assessment, six sampling points were selected within the Village Shivrajpur Patti and water samples were collected from these hand pumps.

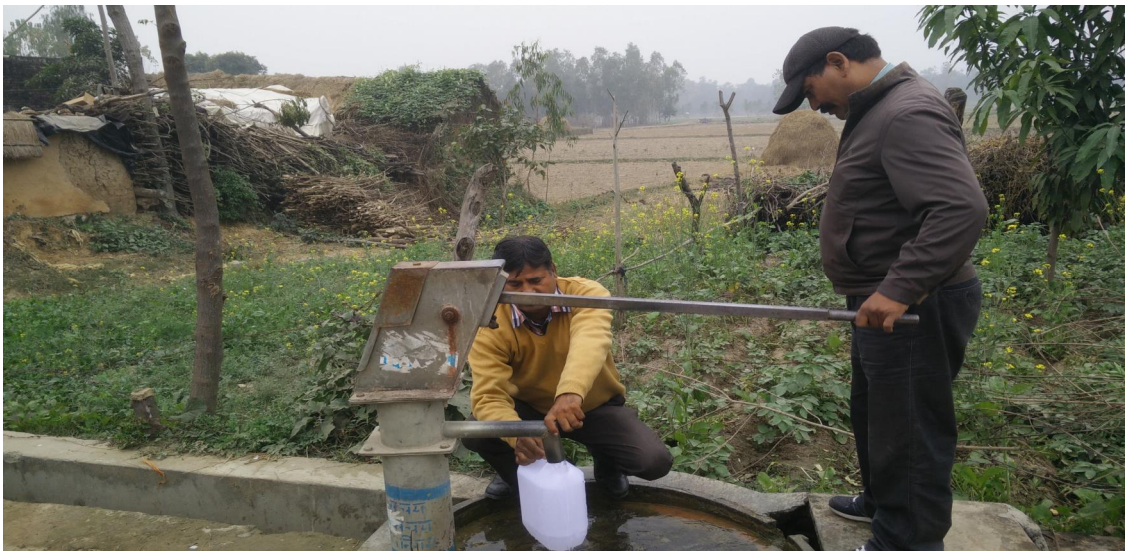
c) The ground water samples collected from these hand pumps were analysed for parameters as per MoEF SO 2151 Dated 17 June, 2005 and compared with IS 10500:2012 (Drinking Water Standard). All the parameters were analysed as per the standard methods prescribed in ñStandard Methods for the Examination of Water and Waste Waterò, APHA 2012.

d) Alkalinity, Ammonia, Arsenic, Bio-chemical Oxygen Demand, Boron, Cadmium, Calcium, Chloride, Chromium Total, Chemical Oxygen Demand, Colour, Conductivity, Dissolved Oxygen, *E. coli*, Fecal Coliform, Fecal Streptococcus, Fluoride, Hardness, Iron, Lead, Magnesium, Mercury, Mineral Oil, Nickel, Nitrate, Nitrite, pH, Phosphorus, Potassium, Sodium, Sulphate, Temperature, Total Coliform, Total Dissolved Solids, Total Plate Count, Turbidity and Zinc parameters were analysed as per Standard Method (APHA 2012)

4. OBSERVATIONS AND DESCRIPTION OF GROUND WATER SAMPLING POINTS

1) ***In Front of House of Sh. Baburam :*** Water sample was collected from a hand pump from this location. The depth of this hand pump is 95 feet approx. This hand pump is situated near the fields and adjacent to a pucca drain. This hand pump appeared to be new and in a good condition with cemented platform. Figure 2





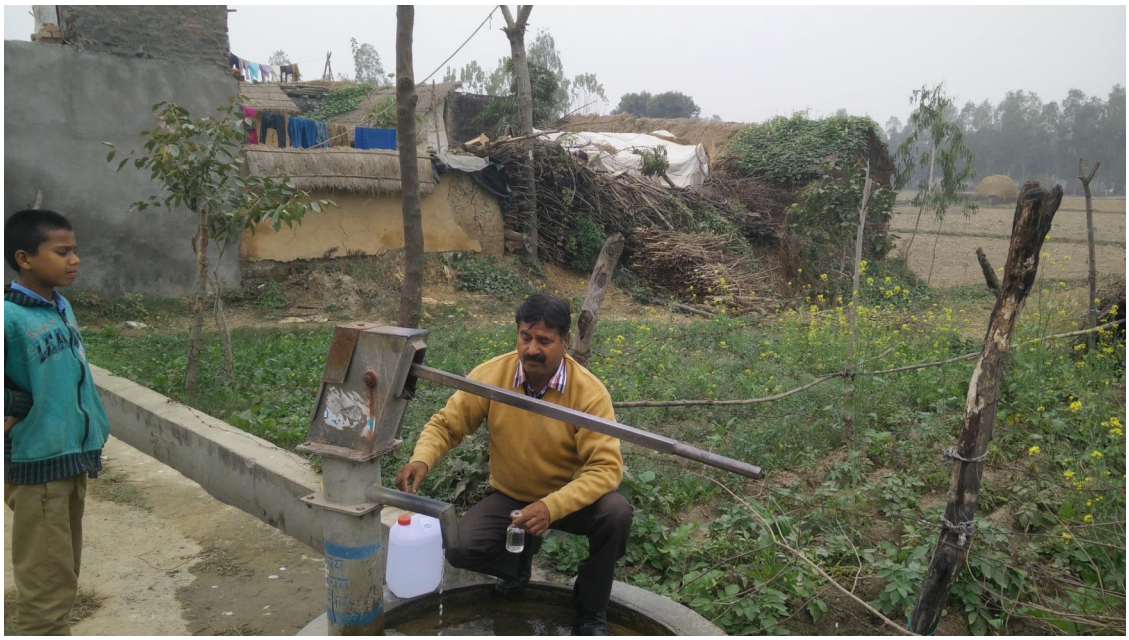


Figure 2 : ***Hand Pump In Front of House of Sh. Baburam***

2) ***In Front of House of Sh. Dharamveer :*** Water sample was collected from a hand pump from this location. The depth of this hand pump is approximately 280 feet. This hand pump is situated near a house and adjacent to a dirty drain. This hand pump also appeared to be new with cemented platform. Cattles are also being tied in the ground adjacent to the hand pump.

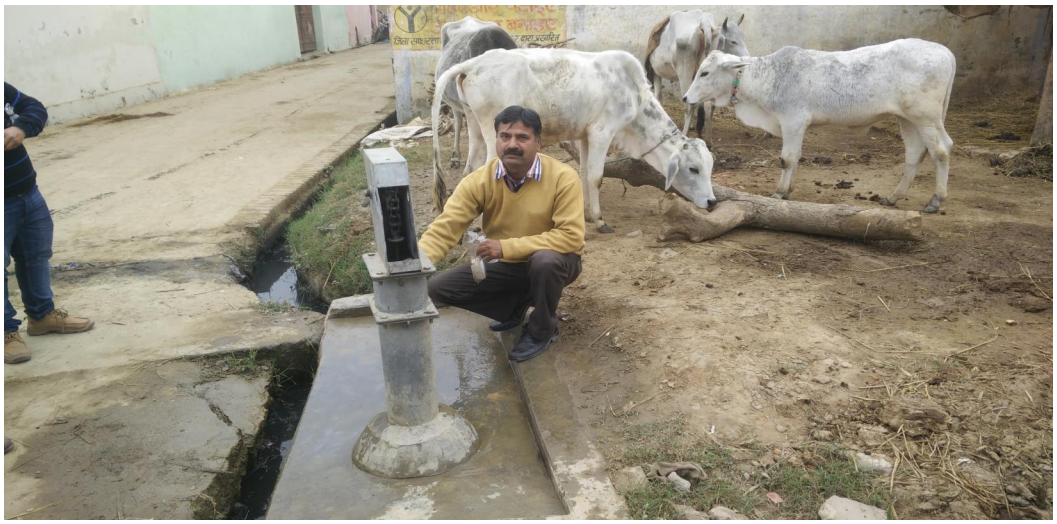
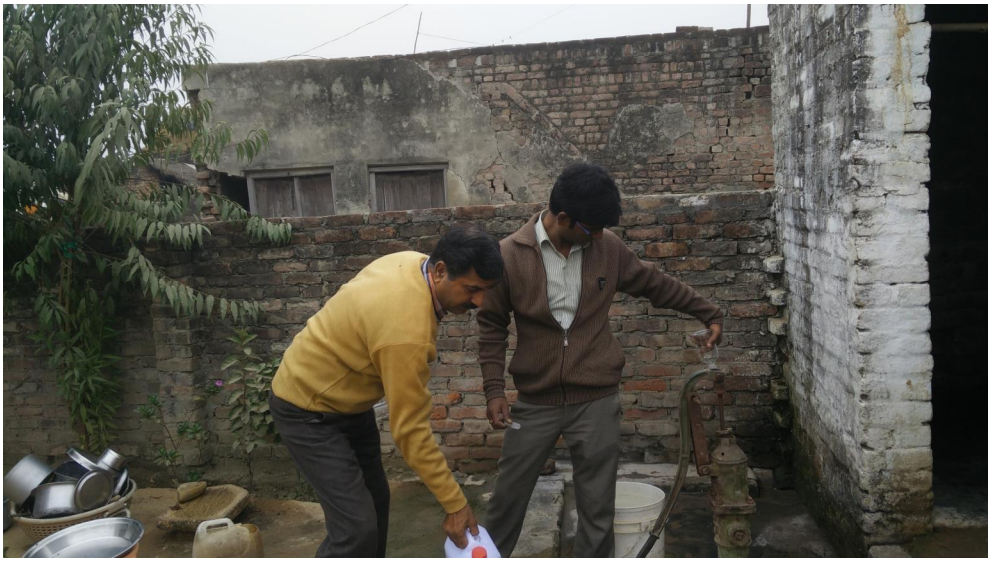


Figure 3 : ***Hand Pump In Front of House of Sh. Dharamveer***

3) ***From the House of Sh. Kartar Singh :*** Water sample was collected from a hand pump located in the house of Shri Kartar Singh. The depth of this hand pump is approximately 25 feet. This hand pump is situated inside the premises of the house. This hand pump appeared to be quite old, rusted and in a dilapidated condition. This hand pump was situated adjacent to the toilet in the house.



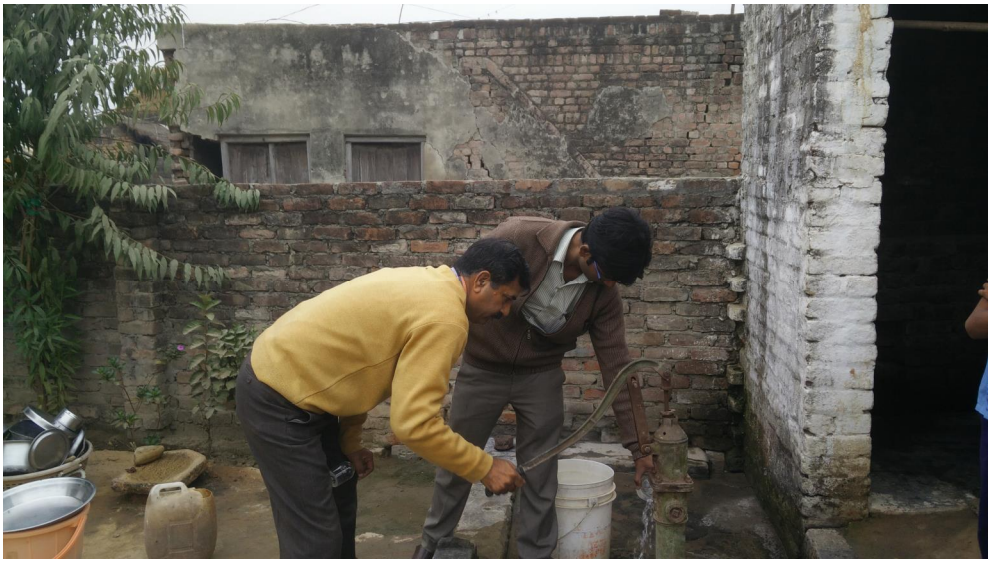


Figure 4 : *Hand Pump In Front of House of Kartar Singh*

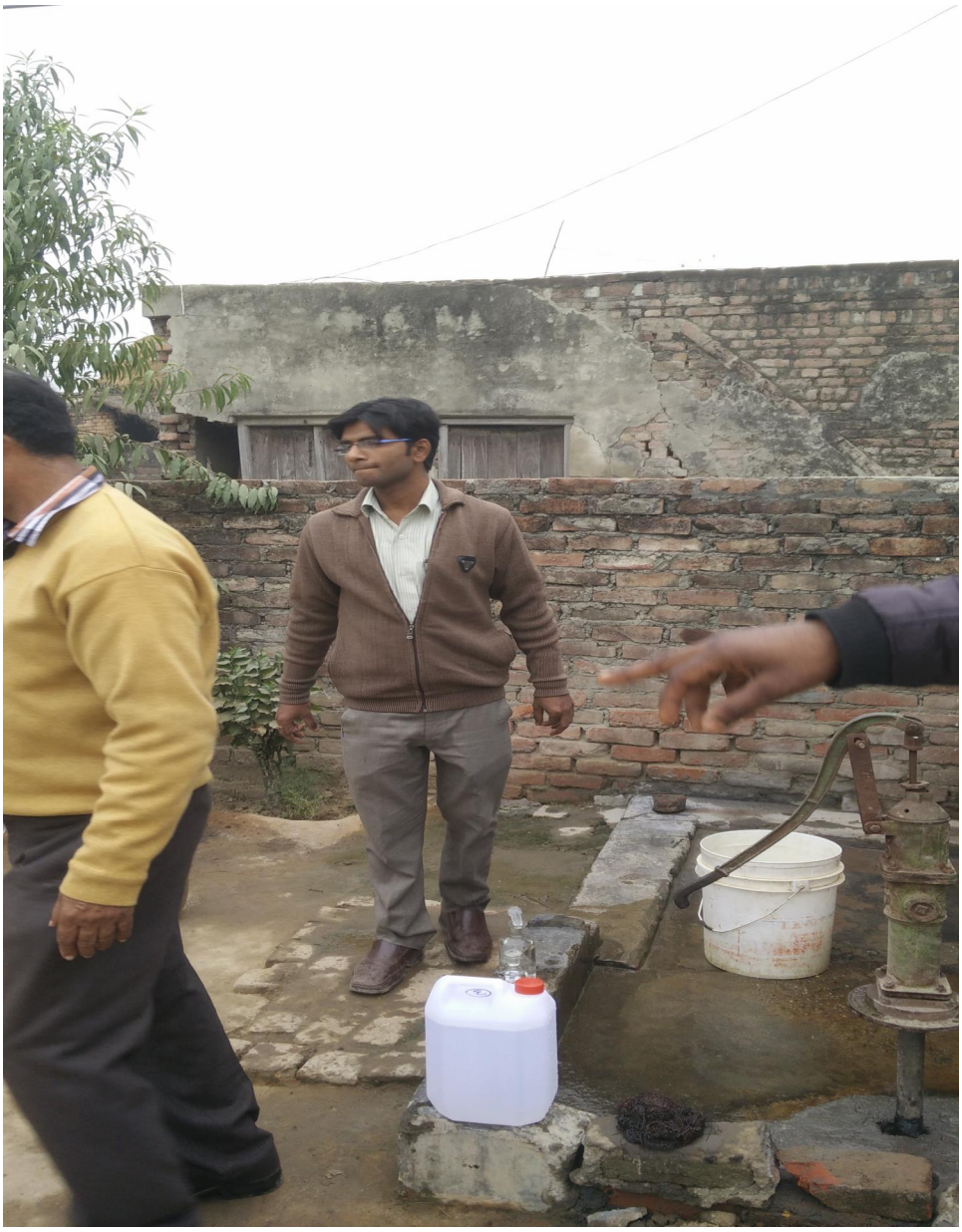
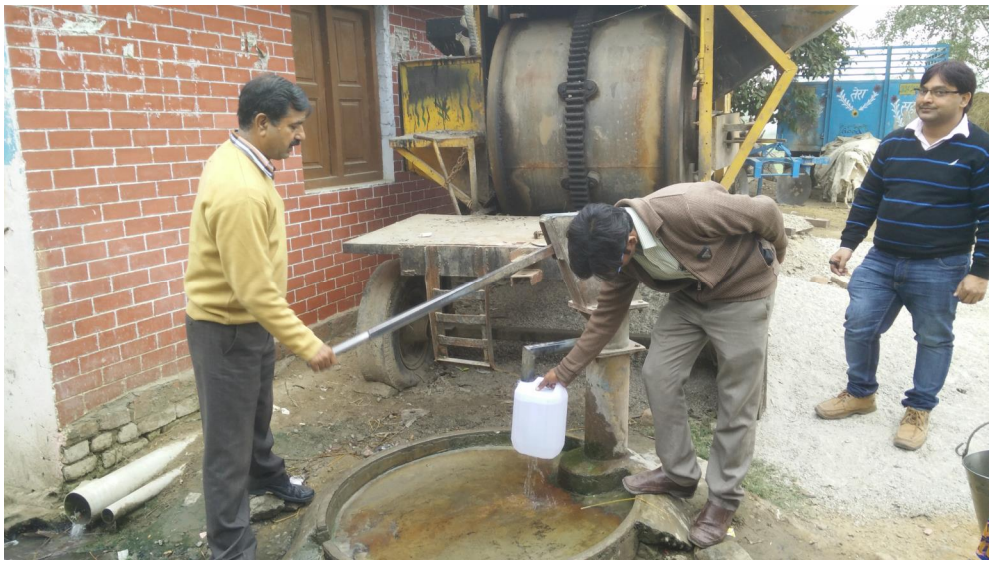


Figure 4 : ***Hand Pump In Front of House of Kartar Singh***

5. ***In Front of House of Sh. Ant Ram :*** Water sample was collected from a hand pump located outside the house of Shri Ant Ram. The depth of this hand pump is approximately 70 feet. This hand pump is situated near the house and also adjacent to a dirty drain. This hand pump apparently appeared to be new and in a better condition.



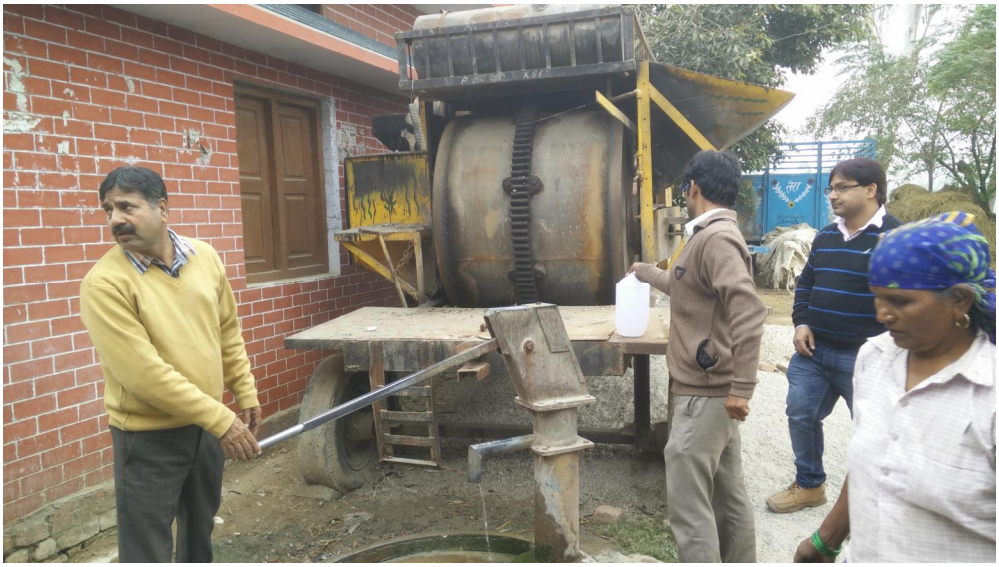
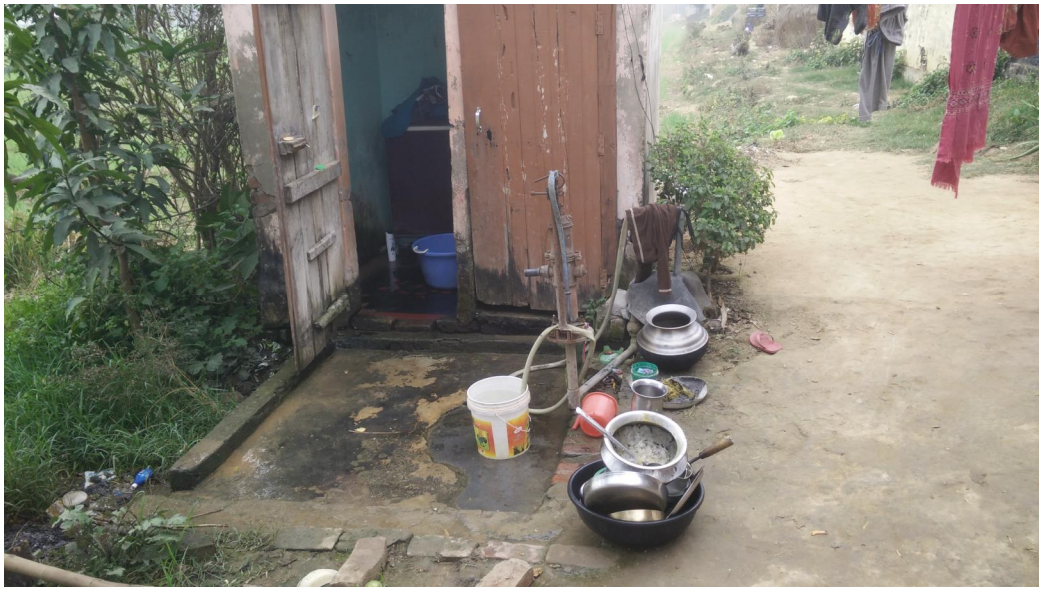


Figure 5 : ***Hand Pump In Front of House of Sh Ant Ram***

6. ***From the House of Sh. Mukesh Kumar (Gram Pradhan) :*** Water sample was collected from a hand pump located inside the house of Shri Mukesh Kumar. The depth of this hand pump is approximately 25 feet. This hand pump is situated inside the premises of the house. This hand pump also appeared to be quite old and rusted but comparatively in a better condition. This hand pump was also situated adjacent to the toilet and bathroom in the house.



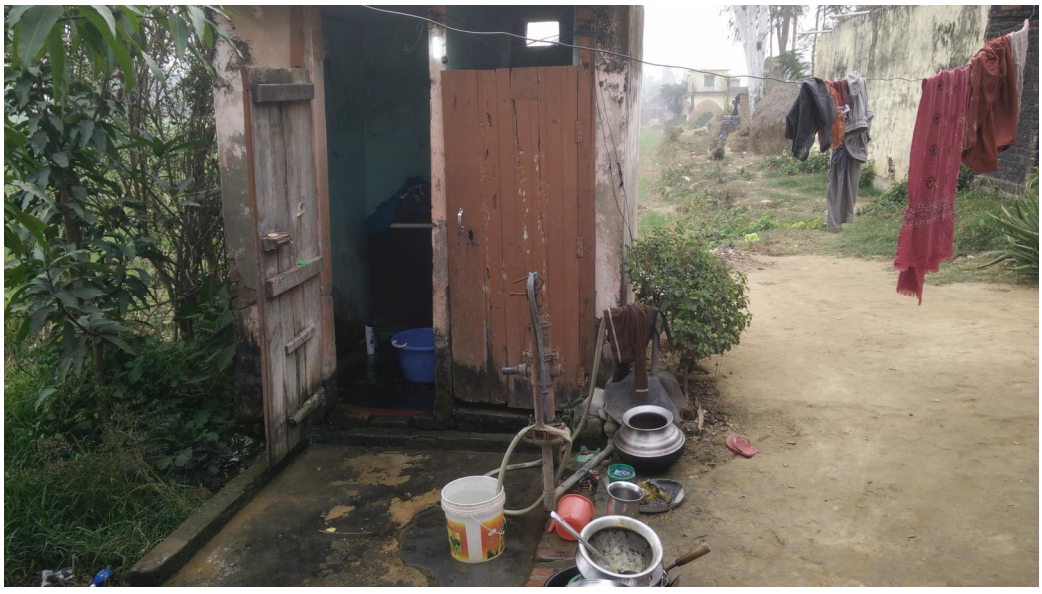
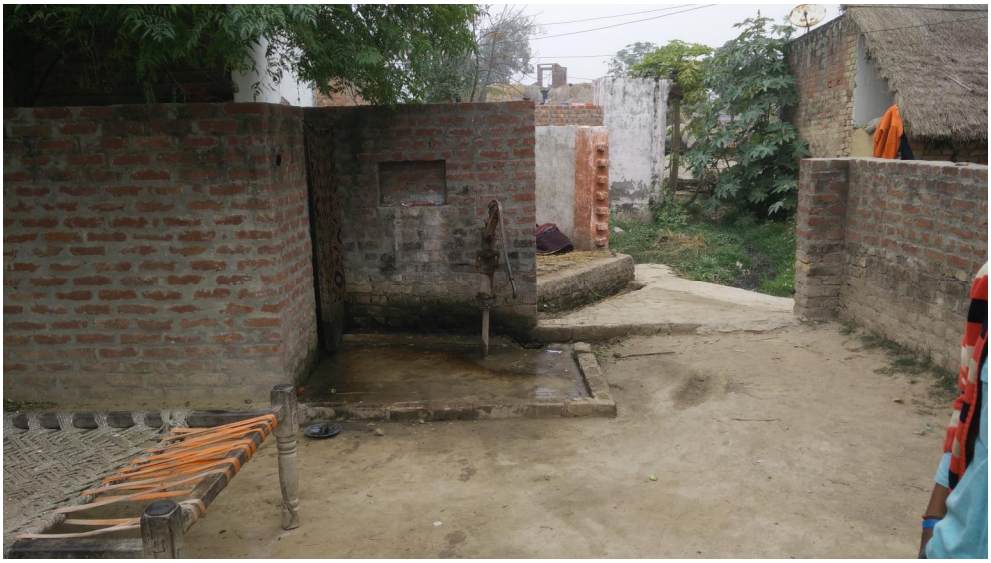


Figure 6 : ***Hand Pump In Front of House of Sh Mukesh Kumar***

1) ***From the House of Sh. Natthu Singh :*** The water sample was collected from a hand pump located inside the house of Shri Natthu Singh. The depth of this hand pump is approximately 20 feet. This hand pump is situated inside the premises of the house. This hand pump also appeared to be quite old and rusted. This hand pump was also situated adjacent to the toilet in the house.



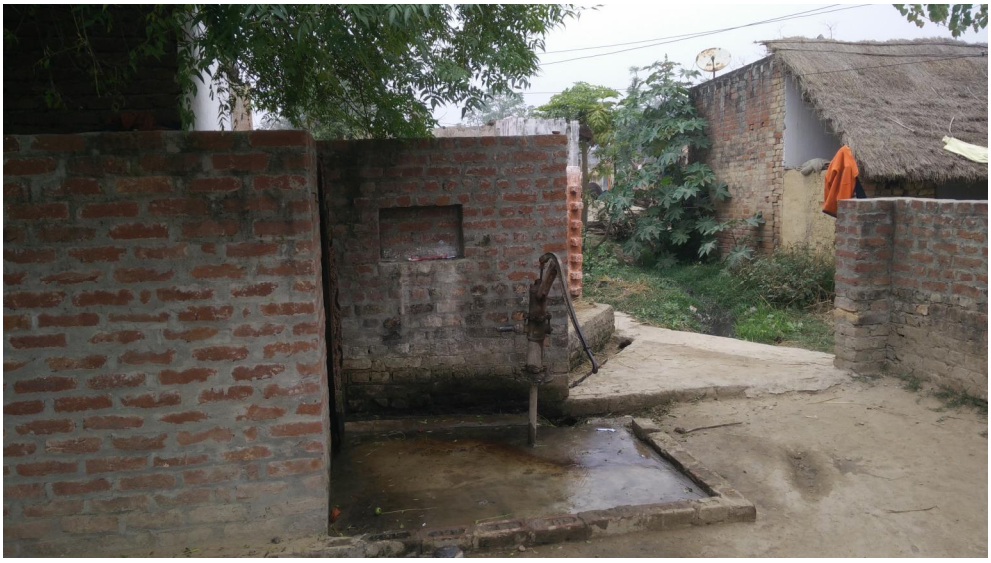


Figure 7 : *Hand Pump In Front of House of Sh Natthu Singh*

7. RESULTS AND DISCUSSION

The Ground water samples were collected from different hand pumps located in the Village Shivrajpur Patti and analysed for the following parameters and compared with Specifications for Drinking Water (IS 10500:2012) :

Alkalinity, Ammonia, Arsenic, Bio-chemical Oxygen Demand, Boron, Cadmium, Calcium, Chloride, Chromium Total, Chemical Oxygen Demand, Colour, Conductivity, Dissolved Oxygen, *E. coli*, Fecal Coliform, Fecal Streptococcus, Fluoride, Hardness, Iron, Lead, Magnesium, Mercury, Mineral Oil, Nickel, Nitrate, Nitrite, pH, Phosphorus, Potassium, Sodium, Sulphate, Temperature, Total Coliform, Total Dissolved Solids, Total Plate Count, Turbidity and Zinc. The acceptable and permissible limits for drinking water as per IS 10500:2012 are given in Table **5.1 :**

TABLE 5.1

Specification for Drinking Water (as per IS 10500:2012)

S.N.	PARAMETER	UNIT	STANDARD LIMITS (IS 10500:2012)	
			Acceptable	Permissible
01.	Alkalinity	mg/L	200	600
02.	Ammonia	mg/L	0.5	0.5
03.	Arsenic	mg/L	0.01	0.05
04.	BOD_3 at 27°C	mg/L	-	-
05.	Boron	mg/L	0.5	1.0
06.	Cadmium	mg/L	0.003	0.003
07.	Calcium	mg/L	75	200
08.	Chloride	mg/L	250	1000
09.	Chromium Total	mg/L	0.05	0.05
10.	COD	mg/L	-	-
11.	Colour	Hazen	5	15
12.	Conductivity	µmhos/cm	-	-
13.	Dissolved Oxygen	mg/L	-	-
14.	*E. coli*	MPN/100 mL	Absent	Absent
15.	Fecal Coliform	MPN/100 mL	Absent	Absent
16.	Fecal Streptococcus	MPN/100 mL	-	-
17.	Fluoride	mg/L	1.0	1.5
18.	Hardness	mg/L	200	600
19.	Iron	mg/L	0.3	0.3
20.	Lead	mg/L	0.01	0.01
21.	Magnesium	mg/L	30	100
22.	Mercury	mg/L	0.001	0.001
23.	Mineral Oil	mg/L	0.5	0.5
24.	Nickel	mg/L	0.02	0.02
25.	Nitrate	mg/L	45	45
26.	Nitrite	mg/L	-	-
27.	pH	-	6.5-8.5	6.5-8.5
28.	Phosphorus	mg/L	-	-
29.	Potassium	mg/L	-	-
30.	Sodium	mg/L	-	-
31.	Sulphate	mg/L	200	400
32.	Temperature	°C	-	-
33.	Total Coliform	MPN/100 mL	Absent	Absent
34.	Total Dissolved Solids	mg/L	500	2000
35.	Total Plate Count	CFU/mL	-	-
36.	Turbidity	NTU	1	5
37.	Zinc	mg/L	5	15

The analysis results of these samples collected from various locations are shown in **Table 5.2 to 5.7.**

TABLE 5.2

i. ***Drinking Water Sample In Front of House of Sh. Baburam :***

PARAMETER	UNIT	OBTAINED VALUE	STANDARD LIMITS (IS 10500:2012)	
			Acceptable	Permissible
Alkalinity	mg/L	328	200	600
Ammonia (as Total Ammonia ï N)	mg/L	ND	0.5	0.5
Arsenic (as As)	mg/L	ND	0.01	0.05
BOD_3 at 27°C	mg/L	4	-	-
Boron (as B)	mg/L	ND	0.5	1.0
Cadmium (as Cd)	mg/L	ND	0.003	0.003
Calcium (as Ca)	mg/L	44.9	75	200
Chloride (as Cl)	mg/L	26	250	1000
Chromium Total (as Cr)	mg/L	ND	0.05	0.05
COD	mg/L	24	-	-
Colour	Hazen	<5	5	15
Conductivity	µmhos/cm	491	-	-
Dissolved Oxygen	mg/L	1.9	-	-
E. coli	MPN/100 mL	Absent	Absent	Absent
Fecal Coliform	MPN/100 mL	Absent	Absent	Absent
Fecal Streptococcus	MPN/100 mL	Absent	-	-
Fluoride (as F)	mg/L	0.89	1.0	1.5
Hardness (as $CaCO_3$)	mg/L	200	200	600
Iron (as Fe)	mg/L	0.06	0.3	0.3
Lead (as Pb)	mg/L	0.01	0.01	0.01
Magnesium (as Mg)	mg/L	21.3	30	100
Mercury (as Hg)	mg/L	ND	0.001	0.001
Mineral Oil	mg/L	ND	0.5	0.5
Nickel (as Ni)	mg/L	ND	0.02	0.02
Nitrate (as NO_3)	mg/L	ND	45	45
Nitrite (as NO_2)	mg/L	ND	-	-
pH	-	7.6	6.5-8.5	6.5-8.5
Phosphorus (as P)	mg/L	0.11	-	-
Potassium (as K)	mg/L	2.93	-	-
Sodium (as Na)	mg/L	26.91	-	-
Sulphate (as SO_4)	mg/L	0.75	200	400
Temperature	°C	25.3	-	-
Total Coliform	MPN/100 mL	Absent	Absent	Absent
Total Dissolved Solids	mg/L	308	500	2000
Total Plate Count	CFU/mL	$2x10^5$	-	-
Turbidity	NTU	1.36	1	5
Zinc (as Zn)	mg/L	0.03	5	15

On comparing with Drinking Water Standard IS:10500 all the parameters are well within drinking water acceptable limits except for Alkalinity and Turbidity. However, these values are well within the permissible limits. The water can therefore be used

for drinking after treatment. No microbial contamination has been detected at this location.

TABLE 5.3

ii. *Drinking Water Sample In Front of House of Sh. Dharamveer :*

PARAMETER	UNIT	OBTAINED VALUE	STANDARD LIMITS (IS 10500:2012)	
			Acceptable	Permissible
Alkalinity	mg/L	298	200	600
Ammonia (as Total Ammonia ï N)	mg/L	ND	0.5	NR
Arsenic (as As)	mg/L	ND	0.01	0.05
BOD_3 at 27°C	mg/L	1.6	-	-
Boron (as B)	mg/L	ND	0.5	1.0
Cadmium (as Cd)	mg/L	ND	0.003	NR
Calcium (as Ca)	mg/L	44.9	75	200
Chloride (as Cl)	mg/L	24	250	1000
Chromium Total (as Cr)	mg/L	ND	0.05	NR
COD	mg/L	8	-	-
Colour	Hazen	<5	5	15
Conductivity	µmhos/cm	469	-	-
Dissolved Oxygen	mg/L	1.7	-	-
E. coli	MPN/100 mL	Absent	Absent	NR
Fecal Coliform	MPN/100 mL	Absent	Absent	NR
Fecal Streptococcus	MPN/100 mL	Absent	-	-
Fluoride (as F)	mg/L	0.90	1.0	1.5
Hardness (as $CaCO_3$)	mg/L	196	200	600
Iron (as Fe)	mg/L	0.05	0.3	NR
Lead (as Pb)	mg/L	0.01	0.01	NR
Magnesium (as Mg)	mg/L	20.3	30	100
Mercury (as Hg)	mg/L	ND	0.001	NR
Mineral Oil	mg/L	ND	0.5	NR
Nickel (as Ni)	mg/L	ND	0.02	NR
Nitrate (as NO_3)	mg/L	ND	45	NR
Nitrite (as NO_2)	mg/L	ND	-	-
pH	-	7.5	6.5-8.5	NR
Phosphorus (as P)	mg/L	ND	-	-
Potassium (as K)	mg/L	2.84	-	-
Sodium (as Na)	mg/L	25.81	-	-
Sulphate (as SO_4)	mg/L	0.86	200	400
Temperature	°C	25.1	-	-
Total Coliform	MPN/100 mL	Absent	Absent	NR
Total Dissolved Solids	mg/L	312	500	2000
Total Plate Count	CFU/mL	$3x10^5$	-	-
Turbidity	NTU	1.61	1	5
Zinc (as Zn)	mg/L	0.06	5	15

On comparing with Drinking Water Standard IS:10500 all the parameters are well within drinking water acceptable limits except for Alkalinity and Turbidity. However, these values are well within the permissible limits. The water can therefore be used

for drinking after treatment. No microbial contamination has been detected at this location also.

TABLE 5.4

iii. ***Drinking Water Sample From the House of Sh. Kartar Singh :***

PARAMETER	UNIT	OBTAINED VALUE	STANDARD LIMITS (IS 10500:2012)	
			Acceptable	Permissible
Alkalinity	mg/L	428	200	600
Ammonia (as Total Ammonia ï N)	mg/L	ND	0.5	NR
Arsenic (as As)	mg/L	ND	0.01	0.05
BOD_3 at 27°C	mg/L	3	-	-
Boron (as B)	mg/L	ND	0.5	1.0
Cadmium (as Cd)	mg/L	ND	0.003	NR
Calcium (as Ca)	mg/L	120.2	75	200
Chloride (as Cl)	mg/L	42	250	1000
Chromium Total (as Cr)	mg/L	ND	0.05	NR
COD	mg/L	20	-	-
Colour	Hazen	<5	5	15
Conductivity	µmhos/cm	1248	-	-
Dissolved Oxygen	mg/L	0.5	-	-
E. coli	MPN/100 mL	Absent	Absent	NR
Fecal Coliform	MPN/100 mL	1	Absent	NR
Fecal Streptococcus	MPN/100 mL	Absent	-	-
Fluoride (as F)	mg/L	0.53	1.0	1.5
Hardness (as $CaCO_3$)	mg/L	312	200	600
Iron (as Fe)	mg/L	0.18	0.3	NR
Lead (as Pb)	mg/L	0.01	0.01	NR
Magnesium (as Mg)	mg/L	22.2	30	100
Mercury (as Hg)	mg/L	ND	0.001	NR
Mineral Oil	mg/L	ND	0.5	NR
Nickel (as Ni)	mg/L	ND	0.02	NR
Nitrate (as NO_3)	mg/L	ND	45	NR
Nitrite (as NO_2)	mg/L	ND	-	-
pH	-	6.4	6.5-8.5	NR
Phosphorus (as P)	mg/L	0.03	-	-
Potassium (as K)	mg/L	3.71	-	-
Sodium (as Na)	mg/L	35.74	-	-
Sulphate (as SO_4)	mg/L	44.5	200	400
Temperature	°C	25.6	-	-
Total Coliform	MPN/100 mL	4	Absent	NR
Total Dissolved Solids	mg/L	712	500	2000
Total Plate Count	CFU/mL	$5x10^5$	-	-
Turbidity	NTU	6.4	1	5
Zinc (as Zn)	mg/L	0.09	5	15

On comparing with Drinking Water Standard IS:10500 all the parameters are well within drinking water acceptable limits except for Alkalinity, Calcium, Fecal Coliform, Hardness, Total Coliform, Total Dissolved Solids and Turbidity. However, these

values are well within the permissible limits except Total Coliform, Fecal Coliform and Turbidity. Also, the pH is slightly below the acceptable limit. The water is therefore polluted also having microbiological contamination as well. This water is therefore not fit for drinking purposes.

TABLE 5.5

iv. *Drinking Water Sample In Front of House of Sh. Ant Ram :*

PARAMETER	UNIT	OBTAINED VALUE	STANDARD LIMITS (IS 10500:2012)	
			Acceptable	Permissible
Alkalinity	mg/L	288	200	600
Ammonia (as Total Ammonia ï N)	mg/L	ND	0.5	NR
Arsenic (as As)	mg/L	ND	0.01	0.05
BOD_3 at 27°C	mg/L	8	-	-
Boron (as B)	mg/L	ND	0.5	1.0
Cadmium (as Cd)	mg/L	ND	0.003	NR
Calcium (as Ca)	mg/L	43.3	75	200
Chloride (as Cl)	mg/L	28	250	1000
Chromium Total (as Cr)	mg/L	ND	0.05	NR
COD	mg/L	48	-	-
Colour	Hazen	<5	5	15
Conductivity	µmhos/cm	588	-	-
Dissolved Oxygen	mg/L	1.5	-	-
E. coli	MPN/100 mL	Absent	Absent	NR
Fecal Coliform	MPN/100 mL	1	Absent	NR
Fecal Streptococcus	MPN/100 mL	Absent	-	-
Fluoride (as F)	mg/L	0.65	1.0	1.5
Hardness (as $CaCO_3$)	mg/L	224	200	600
Iron (as Fe)	mg/L	0.04	0.3	NR
Lead (as Pb)	mg/L	0.01	0.01	NR
Magnesium (as Mg)	mg/L	28.1	30	100
Mercury (as Hg)	mg/L	ND	0.001	NR
Mineral Oil	mg/L	ND	0.5	NR
Nickel (as Ni)	mg/L	ND	0.02	NR
Nitrate (as NO_3)	mg/L	ND	45	NR
Nitrite (as NO_2)	mg/L	ND	-	-
pH	-	8.20	6.5-8.5	NR
Phosphorus (as P)	mg/L	0.25	-	-
Potassium (as K)	mg/L	2.56	-	-
Sodium (as Na)	mg/L	26.32	-	-
Sulphate (as SO_4)	mg/L	6.40	200	400
Temperature	°C	25.6	-	-
Total Coliform	MPN/100 mL	3	Absent	NR
Total Dissolved Solids	mg/L	338	500	2000
Total Plate Count	CFU/mL	$4x10^5$	-	-
Turbidity	NTU	8.1	1	5
Zinc (as Zn)	mg/L	0.13	5	15

On comparing with Drinking Water Standard IS:10500 all the parameters are well within drinking water acceptable limits except for Alkalinity, Fecal Coliform, Hardness, Total Coliform and Turbidity. However, these values are well within the permissible limits except Total Coliform, Fecal Coliform and Turbidity. The water is having microbiological contamination also. This water is therefore not fit for drinking purposes.

TABLE 5.6

v. *Drinking Water Sample From the House of Sh. Mukesh Kumar (Gram Pradhan):*

PARAMETER	**UNIT**	**OBTAINED VALUE**	**STANDARD LIMITS (IS 10500:2012)**	
			Acceptable	**Permissible**
Alkalinity	mg/L	288	200	600
Ammonia (as Total Ammonia ï N)	mg/L	ND	0.5	NR
Arsenic (as As)	mg/L	ND	0.01	0.05
BOD_3 at 27°C	mg/L	3	-	-
Boron (as B)	mg/L	ND	0.5	1.0
Cadmium (as Cd)	mg/L	ND	0.003	NR
Calcium (as Ca)	mg/L	75.3	75	200
Chloride (as Cl)	mg/L	30	250	1000
Chromium Total (as Cr)	mg/L	ND	0.05	NR
COD	mg/L	20	-	-
Colour	Hazen	<5	5	15
Conductivity	µmhos/cm	670	-	-
Dissolved Oxygen	mg/L	1.0	-	-
E. coli	MPN/100 mL	Absent	Absent	NR
Fecal Coliform	MPN/100 mL	2	Absent	NR
Fecal Streptococcus	MPN/100 mL	Absent	-	-
Fluoride (as F)	mg/L	0.53	1.0	1.5
Hardness (as $CaCO_3$)	mg/L	236	200	600
Iron (as Fe)	mg/L	0.07	0.3	NR
Lead (as Pb)	mg/L	0.01	0.01	NR
Magnesium (as Mg)	mg/L	11.6	30	100
Mercury (as Hg)	mg/L	ND	0.001	NR
Mineral Oil	mg/L	ND	0.5	NR
Nickel (as Ni)	mg/L	ND	0.02	NR
Nitrate (as NO_3)	mg/L	ND	45	NR
Nitrite (as NO_2)	mg/L	ND	-	-
pH	-	7.9	6.5-8.5	NR
Phosphorus (as P)	mg/L	ND	-	-
Potassium (as K)	mg/L	2.81	-	-
Sodium (as Na)	mg/L	24.17	-	-
Sulphate (as SO_4)	mg/L	23.9	200	400
Temperature	°C	23.7	-	-
Total Coliform	MPN/100 mL	4	Absent	NR
Total Dissolved Solids	mg/L	378	500	2000
Total Plate Count	CFU/mL	$6x10^5$	-	-
Turbidity	NTU	2.40	1	5
Zinc (as Zn)	mg/L	0.07	5	15

On comparing with Drinking Water Standard IS:10500 all the parameters are well within drinking water acceptable limits except for Alkalinity, Calcium, Fecal Coliform, Hardness, Total Coliform and Turbidity. However, these values are well within the permissible limits except Total Coliform and Fecal Coliform. The water is having coliforms as microbiological contamination. This water is therefore not fit for drinking purposes.

TABLE 5.7

vi. ***Drinking Water Sample From the House of Sh. Natthu Singh:***

PARAMETER	**UNIT**	**OBTAINED VALUE**	**STANDARD LIMITS (IS 10500:2012)**	
			Acceptable	**Permissible**
Alkalinity	mg/L	620	200	600
Ammonia (as Total Ammonia ï N)	mg/L	ND	0.5	NR
Arsenic (as As)	mg/L	ND	0.01	0.05
BOD_3 at 27°C	mg/L	8	-	-
Boron (as B)	mg/L	ND	0.5	1.0
Cadmium (as Cd)	mg/L	ND	0.003	NR
Calcium (as Ca)	mg/L	104.2	75	200
Chloride (as Cl)	mg/L	48	250	1000
Chromium Total (as Cr)	mg/L	ND	0.05	NR
COD	mg/L	44	-	-
Colour	Hazen	<5	5	15
Conductivity	µmhos/cm	1638	-	-
Dissolved Oxygen	mg/L	0.5	-	-
E. coli	MPN/100 mL	2	Absent	NR
Fecal Coliform	MPN/100 mL	3	Absent	NR
Fecal Streptococcus	MPN/100 mL	Absent	-	-
Fluoride (as F)	mg/L	0.89	1.0	1.5
Hardness (as $CaCO_3$)	mg/L	488	200	600
Iron (as Fe)	mg/L	0.26	0.3	NR
Lead (as Pb)	mg/L	0.01	0.01	NR
Magnesium (as Mg)	mg/L	55.3	30	100
Mercury (as Hg)	mg/L	ND	0.001	NR
Mineral Oil	mg/L	ND	0.5	NR
Nickel (as Ni)	mg/L	ND	0.02	NR
Nitrate (as NO_3)	mg/L	10	45	NR
Nitrite (as NO_2)	mg/L	ND	-	-
pH	-	7.1	6.5-8.5	NR
Phosphorus (as P)	mg/L	0.05	-	-
Potassium (as K)	mg/L	4.36	-	-
Sodium (as Na)	mg/L	35.52	-	-
Sulphate (as SO_4)	mg/L	48.5	200	400
Temperature	°C	24.5	-	-
Total Coliform	MPN/100 mL	8	Absent	NR
Total Dissolved Solids	mg/L	742	500	2000
Total Plate Count	CFU/mL	$12x10^5$	-	-
Turbidity	NTU	45.8	1	5
Zinc (as Zn)	mg/L	0.06	5	15

On comparing with Drinking Water Standard IS:10500 all the parameters are well within drinking water acceptable limits except for Alkalinity, Calcium, *E. coli*, Fecal Coliform, Hardness, Magnesium, Total Coliform, Total Dissolved Solids and Turbidity. However, these values are well within the permissible limits except Alkalinity, *E. coli*, Total Coliform, Fecal Coliform and Turbidity. The water is having total coliform, fecal coliform and *E. coli* as microbiological contamination. This water is therefore not fit for drinking purposes.

The overall summary of Ground Water Monitoring Results is indicated in **Table 5.8**, which indicates the parameters above Standard Acceptable Limit Value and Maximum Permissible Limit values.

TABLE 5.8
Summary of Ground Water Monitoring Data of Identified Hand Pumps at Shivrajpur Village , Block Jaspur, Distt.U S Nagar

S.N.	Name of Sampling Location	Parameters Above	
		Standard Acceptable Value	**Maximum Permissible Value**
1.	H/o Sh. Babu Ram	Alkalinity, Turbidity	-
2.	H/o Sh. Dharamveer	Alkalinity, Turbidity	-
3.	H/o Sh. Kartar Singh	Alkalinity, Calcium, **Fecal Coliform**, Hardness, **Total Coliform**, Total Dissolved Solids, Turbidity	**Total Coliform, Fecal Coliform,** Turbidity
4.	H/o Sh. Ant Ram	Alkalinity, **Fecal Coliform**, Hardness, **Total Coliform**, Turbidity	**Total Coliform, Fecal Coliform**, Turbidity
5.	H/o Sh. Mukesh Kumar (Pradhan)	Alkalinity, Calcium, **Fecal Coliform**, Hardness, **Total Coliform**, Turbidity	**Total Coliform, Fecal Coliform**
6.	H/o Sh. Natthu Singh	Alkalinity, Calcium**, *E. coli*, Fecal Coliform**, Hardness, Magnesium, **Total Coliform**, Total Dissolved Solids Turbidity	Alkalinity, ***E. coli*, Total Coliform, Fecal Coliform,** Turbidity

On comparing the ground water quality analysis results with IS 10500:2012, it is observed that the values of Total Coliform, Fecal Coliform and Turbidity are higher than acceptable as well as the permissible limits at all the locations except the first two. Therefore it could be concluded that Ground Water is safe for drinking and other purposes only at the first two sampling points.

8. RECOMMENDATIONS

Since, most of the hand pumps in the village are contaminated and the water is mostly polluted due to hand pumps mostly being very near to dirty kuchha drains or toilets, following are the recommendations for disinfection of water and installation of hand pumps :

8.1 The Hand Pump should be installed as per the following method :

Installation of the Hand pump

Construction of concrete platform (185 cm dia.) and drain to ensure discharge of waste water at least 3 meters away from the hand pump.

- Properly sloped (1:2) masonry apron should be constructed around the hand pump to prevent accumulation and percolation of dirty water just around the hand pump.
- A smooth drainage channel at least 3 metres long should be constructed from the hand pump to prevent stagnation of water around the hand pump as well as seepage into the hand pump.
- A soak pit should be constructed for disposal of spilled / waste water.

Waste water from a hand pump site can be discharged to kitchen garden, existing drains or soak pit.

Protection of Surrounding of the Hand Pump

Defecation near the hand pump site indiscriminately anywhere in the village should be stopped by common agreement and enforcement by social pressure.

Compost and garbage pits and drains should not be allowed within at least 15 meters radius of the hand pump. Garbage and compost pits should be established in the village away from the water source and their use should be encouraged rather than random waste disposal.

Laundry, bathing, watering and washing of animals should be done about 15 metres away from the hand pump. This will minimize the quantity of waste water to be disposed off from around the immediate vicinity of the pump.

8.2 Proper chlorination in all the Hand pumps is required to be done as per standard practice as per the following :

Wells should be disinfected after initial hand pump installation and subsequent repair. Disinfection techniques should be done as follows:

8.2.1 In case dug well is used for drinking; the dug well water used for drinking should be free from micro-organisms occasionally by chlorinating with measured amount of bleaching powder. It has been observed that 4 mg of bleaching powder given for only one litre of dug well water very effectively destroys the micro-organisms in water and the residential chlorine remains in the range of 0.2-0.5 mg/l.

8.2.2 There should be clear cut instructions for chlorination frequency at Hand Pumps.

8.2.3 There should be proper storage of Bleaching powder or it would be better if liquid chlorine is used.

8.2.4 Awareness about importance of water quality among villagers is required.

Xxx

ANNEXURE : ORIGINAL TEST REPORT
TL50986 to TL50991