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Assessment of Ground Water Quality of Adjoining Area of the Bhiwari Industrial Area (Alwar), Rajasthan

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ABSTRACT

Ground water quality parameters of adjoining villages of Bhiwari industrial area,(Alwar) Rajasthan, India were assessed in this study. Ground water samples were collected from different sources of 10 adjoining villages of Bhiwari industrial area and analysis of parameters such as pH, total dissolved solids, total hardness, fluoride, nitrate, sulphate, biological oxygen demand, chemical oxygen demand, cadmium and lead were carried. Finding parameters were compared with the WHO water quality parameters. It was found that some of the villages under study fall in polluted zone. The results shown that the areas which near to industries have polluted ground water than others.

Keywords: Ground water, physicochemical parameters, contamination, permissible limit, polluted area.

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INTRODUCTION

The accelerated technological advancement especially in the field of mineral and metal processing industry is giving rise to industrial pollution, arising from the growth of industry. The industrial waste water contains toxic metal ions which increases the risk of affecting the quality of water reservoir of the area due to percolation of these hazardous substances through the porous soil of the land to the ground water [2, 4, 5]. Drinking water used for human consumption should be potable and palatable a large number of industries coming up day to day and are releasing polluting effluent, toxic metals, inorganic and organic substances in to the natural water. Bhiwari is fastly developing industrial area with fertilizers, arsenic, fluoride, electroplating, photographic waste industries [10, 11].

This paper highlights the various physico-chemical parameters of ground water from various sources of adjoining villages of Bhiwari industrial area, which will helps us to formulate the strategy for mitigating the harmful effects of ions present above the prescribed levels (Table 2).

MATERIAL AND METHOD

Study area:

Bhiwari is located at the East end of Rajasthan in Tijara tehsil of alwar district. It is within the national capital region, just 55 away from Delhi, 200 kms from state capital Jaipur, 90 kms from district head quarter Alwar (Rajasathan).

There are 59 industrial units producing auto parts, cycle components, service station and allied items, 48 units producing chemicals, cosmetics and allied items such as formaldehyde, spray varnish, PV paste and thinner, unsaturated polyester resin, pehnolic resin, para toluene sulphonic acid and acid slurry, aromatic chemicals, zinc stearate, di-butyl phthlate (DBP) and di-octyl phthlate (DOP), agro chemicals, solvent, sodium hyposulphite, sodium sulphite, zinc sulphate, calcium carbide, lime, resorcinol, refrigerant gases, CMS, rubber processing chemical, zinc oxide etc. Twenty units are producing paints and printing ink, etc. Most industries generally produce wastes containing toxic heavy metals along with hazardous organic and inorganic effluents. These chemicals contaminate the ground water and severely pollute it [4,5].

The present study was planned by selecting ten villages located in adjoining Bhiwari Industrial area (figure 1) and ten ground water samples were collected from selected villages as per standard procedure. The literature survey showed that no groundwater studies were made in these localities so far. Hence the present study was undertaken by authors.

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Table-2:- Standards of water quality parameters

Parameter	International Standard (APHA 1993)		Indian Standard (BIS, 1993)		Ministry of Urban Development		W.H.O (1971)		I.C.M.R. (1975)	
	Max. Acceptable Conc.	Max. Allowable Conc.	Max. Acceptable Conc.	Max. Allowable Conc.	Max. Acceptable Conc.	Max. Allowable Conc.	Max. Acceptable Conc.	Max. Allowable Conc.	Max. Acceptable Conc.	Max. Allowable Conc.
Colour	5 Unites	25 Unites	5 Unites	25 Unites	5 Unites	25 Unites	5 Unites	25 Unites	5 Unites	25 Unites
Odor	Unobjectable	-	Unobjectable	-	Unobjectable	-	Unobjectable	-	Unobjectable	-
Taste	Agreeable	-	Agreeable	-	Agreeable	-	Agreeable	-	Agreeable	-
Turbidity	2.5NTU	10NTU	5 NTU	10 NTU	2.5 NTU	10 NTU	2.5 NTU	10 NTU	2.5 NTU	10 NTU
pH	7.0 to 8.5	6.5to 9.2	6.5 to 8.5		7.5 to 8.5	6.5 to 9.2	7.0 to 8.0	6.5to 9.2	7.0 to 8.6	6.5to 9.2
TH	100	500	300	600	200	600	100	500	360	600
TDS	500	1500	500	2000	500	1500	500	1500	550	1500
Iron	0.1	1.0	0.3	1.0	0.1	1.0	0.1	1.0	0.1	1.0
Calcium	75	200	75	200	75	200	75	200	75	200
Magnesium	30	150	30	150	30	150	80	150	50	100
Chloride	200	600	250	1000	200	1000	200	600	200	1000
Sulphate	200	400	200	400	200	400	200	400	200	400
Nitrate	45	100	45	100	45	100	45	-	20	-
Fluoride	0.7	1.5	0.7	1.5	1.0	1.5	0.9	1.7	1.0	2.0
Zinc	5	1.5	5	1.5	5	1.5	5	1.5		
Copper	0.05	1.5	0.05	1.5	0.05	1.5	0.05	1.5	0.05	1.5
Arsenic	0.05	NR	0.05	NR	0.05	0.05	-		-	-
Cadmium	0.01	NR	0.01	NR	0.01	1.0	-	0.01	0.01	-
Cyanide	0.05	NR	0.05	NR	0.05	0.55	-		-	-
Lead	0.1	NR	0.1	NR	0.1	0.1	-	0.1	0.1	-
Mercury	0.001	NR	0.001	NR	0.1	0.001	-	-	-	-
Selenium	0.01	NR	0.01	NR	0.01	0.01	-	-	-	-
RC	0.2	0.2	-	-	-	-	-	-	-	-
Coliform	-	4	-	4	-	10	-	-	-	-

NR = No relaxation; **RC = Residual chlorine;**
TH = Total hardness

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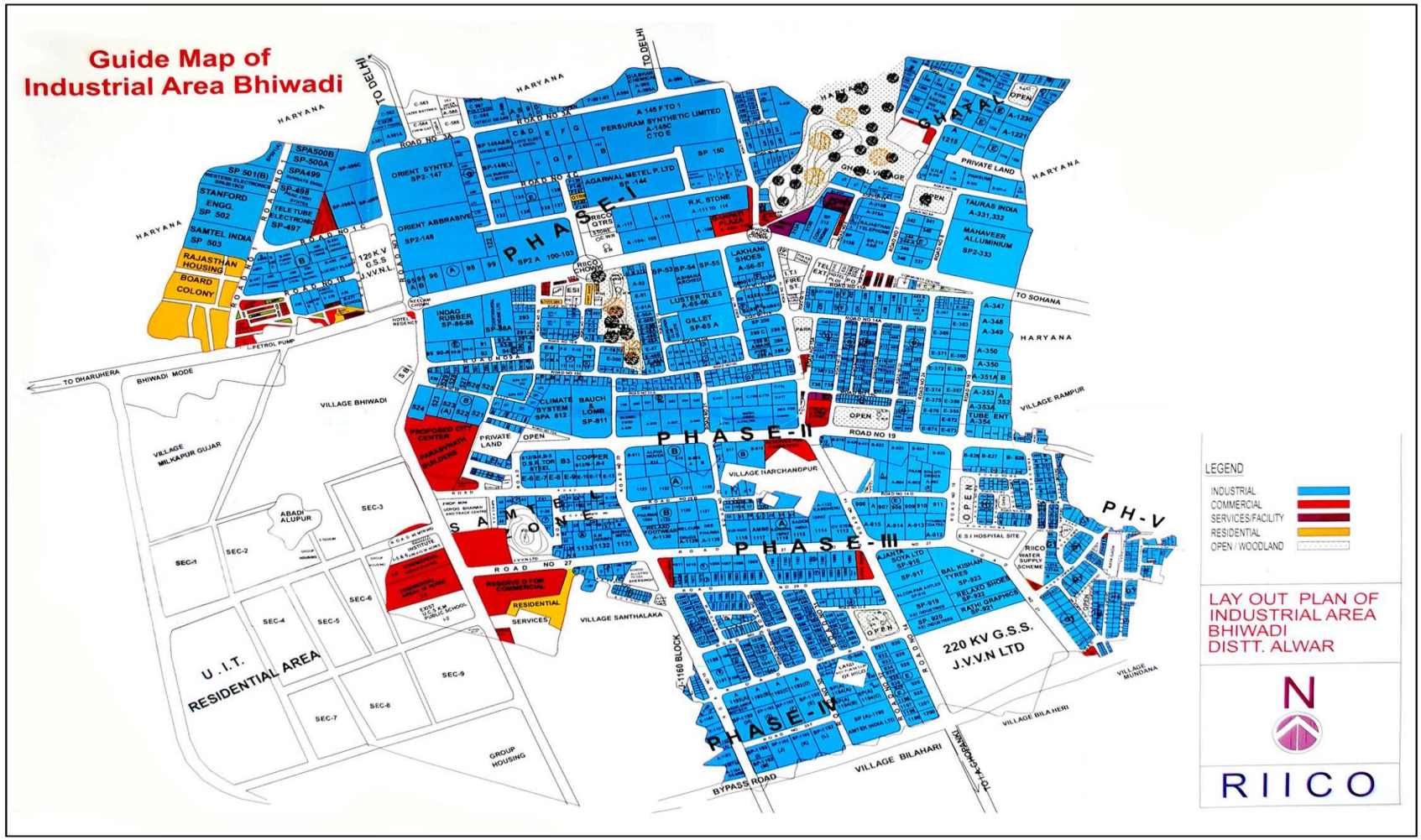

Figure: 1

Collection of ground water samples

The ground water samples were collected in precleaned one-liter plastic bottles from borewells, hand pumps and open wells located adjoining Bhiwari industrial area. Bottles were cleaned with hydrochloric acid then washed with tap water and then rinsed with distilled water twice and again rinsed with the water sample to be collected and field up one-liter bottles with the water samples [6-8]. Some samples which were turbid or containing suspended matter were filtered at the time of collection with membrane filter of porosity 0.45m/u.

Analysis of ground water samples

The physicochemical parameters such as pH, Total Alkalinity (TA), Total Dissolved Solids (TDS), BOD, COD, Total Hardness (TH), Chloride (Cl^-), Nitrate (NO_3^-), Sulphate (SO_4^{-2}), Fluoride (F^-), were determined using standard Methods(1). Specific reagents were used for the analysis and double distilled water was used for preparation of solutions. Results are shown in the Table 1 and figures 2-11.

RESULT AND DISCUSSION

The results obtained are consolidated and mean value for each sample was calculated.

pH

pH is a measure of the intensity of acidity or alkalinity and the concentration of hydrogen ion in water. pH value below 4 produces sour taste and a higher value above 8.5 give alkaline taste [7]. In the present study, the pH values of water samples varied between 6.8 to 7.8 (Table 1) , which is permissible limits as compare to WHO [3,9].

Determination of pH is one of the important objectives for the treatment of waste. Significant changes in pH occur due to the disposal of industrial waste and acid mine drainage.

Total dissolved solids (TDS)

Water cointing more than 500 mg/l of TDS is considered desirable for drinking. In present study the TDS value varies from 580 to 2000 mg/l in the ground water samples Results shown that ground water sample of village Alampur contain four times more TDS than permissible limits. It was noticed that all ten water sample have more TDS as compare to WHO permissible limits [9].

Total Alkalinity (TA)

Total Alkalinity is a total measure of substance in water that has “acid-neutralizing” capacity. The main sources of natural alkalinity are rocks which contain carbonate (CO_3^{2-}), bicarbonate (HCO_3^-) and hydroxide (OH^-) compounds; silicates (SiO_4^{3-}) and phosphates (PO_4^{2-}) may also contribute to alkalinity.

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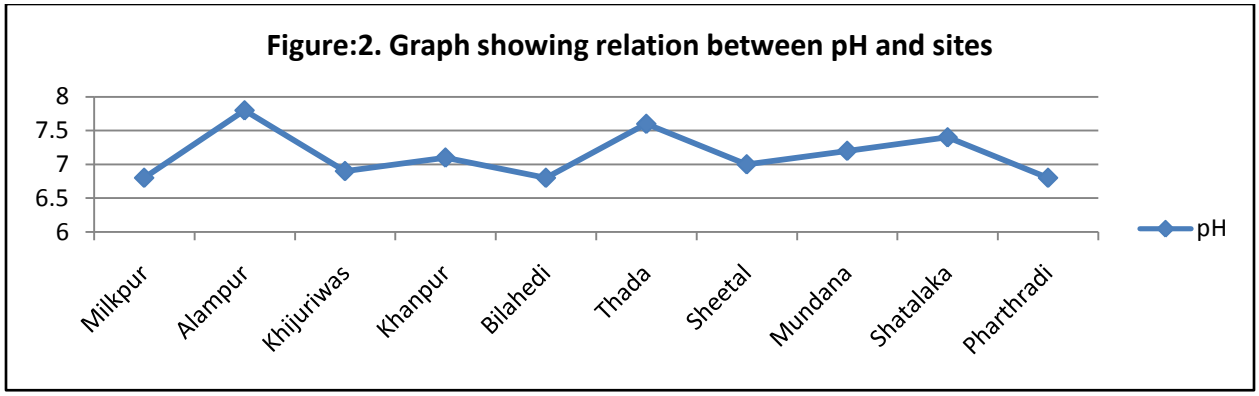
The alkalinity values in the study area varies from 360 to 550 mg/l. 100% samples have alkalinity values above the desirable limit of 200mg/l but within the maximum permissible limit of 600mg/l [3]. The high alkalinity values in the study area may be attributed to the action of carbonates upon the basic materials in the soil. Such water gives unpleasant taste. Calcium and magnesium along with their carbonates and sulphate makes the water hard, both temporary and permanent. A limit of 300mg/l has been recommended as a desirable limit and 600mg/l as the maximum permissible limit for potable water [3].

Table -1: - Values of Various parameter of locations near Bhiwari industrial area.

Location/ source	pH	Cl^-	$NO3^-$	F^-	TDS	$SO4^{-2}$	TH	TA	DO	BOD	COD	Hg	As	Coliform	Cd	Pb	Cr
Milkpur (HP)	6.8	185	28	1.5	780	300	455	400	0	55	150	ND	ND	ND	ND	ND	ND
Alampur (BW)	7.8	480	62	1.8	2000	170	510	386	0	50	175	ND	ND	ND	0.01	0.01	
Khijuriwas (BW)	6.9	200	36	1.2	580	250	480	510	0	75	160	ND	ND	ND	ND	0.01	ND
Khanpur (OW)	7.1	200	25	1.3	1200	280	482	520	0	50	148	ND	ND	ND	ND	ND	0.01
Bilahedi (HP)	6.8	255	30	1.5	750	350	600	550	0	50	145	ND	ND	ND	0.01	0.01	ND
Thada	7.6	430	45	1.4	590	345	700	380	0	60	152	ND	ND	ND	ND	ND	ND
Sheetal	7.0	405	25	1.4	600	340	780	390	0	60	160	ND	ND	ND	ND	ND	ND
Mundana	7.2	650	70	1.8	1400	380	750	400	0	70	148	ND	ND	ND	ND	ND	ND
Shatalaka	7.4	300	32	1.4	1120	372	680	360	0	70	140	ND	ND	ND	ND	ND	ND
Phathradi	6.8	290	45	1.1	1180	190	430	500	0	75	160	ND	ND	ND	ND	ND	ND

DO - Dissolved oxygen; TDS - Total dissolved solid; TH- Total hardness;
TA- Total alkalinity; ND- Not detectable;
All values are in mg/l. except pH and coliform.



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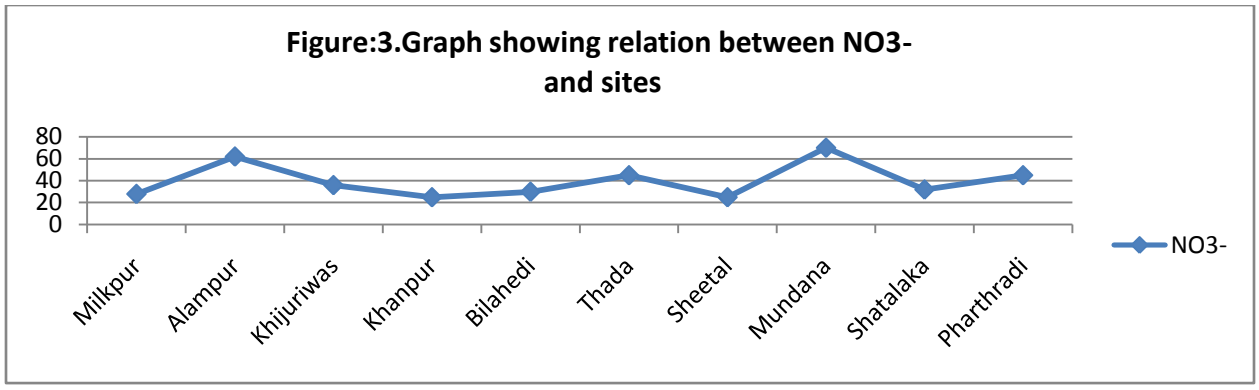

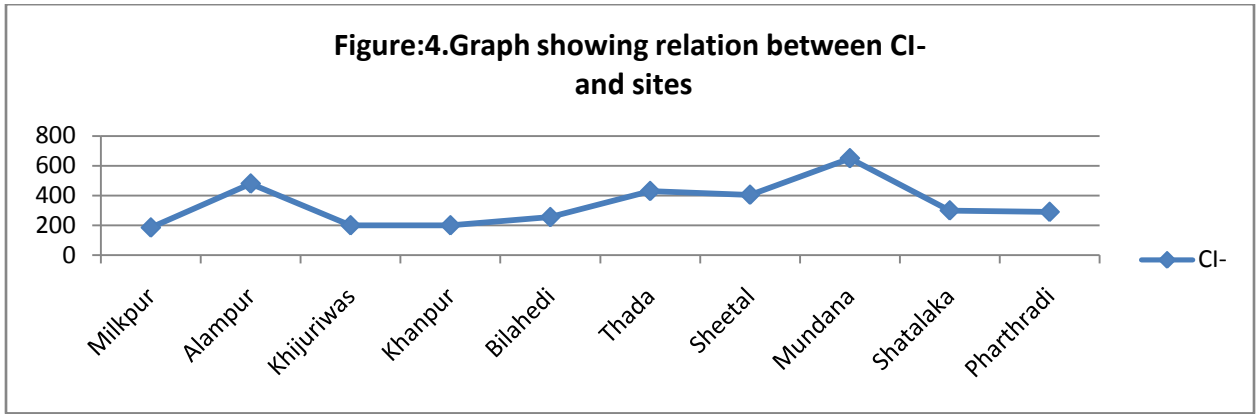

Total hardness (TH)

Hardness in water is due to the natural accumulation of salts from contact with soil and geological formations or it may enter from direct pollution by industrial effluents. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. In the present study, total hardness varied from 370 mg/L to 780 mg/L , So 15% samples showed higher values than permissible limit of drinking water. Ground water samples of some villages such as Almpur, Bilahedi, Thada, Sheetal, Mundana, and Shatalaka have more total hardness value as compare to WHO [9].

Chloride (Cl^-)

The most important source of chlorides in the waters is the discharge of industries sewage. The chloride value in the study area varies from 152 to 650 mg/l. A limit of 250 mg/l chloride has been recommended as desirable limit and 1000mg/l as maximum permissible limit for drinking water [3,9].The chloride values in all the samples are within permissible limit. Only Mundana's village ground water samples have more chloride concentrations as compare to WHO permissible limits [9].

Fluoride (F^-)

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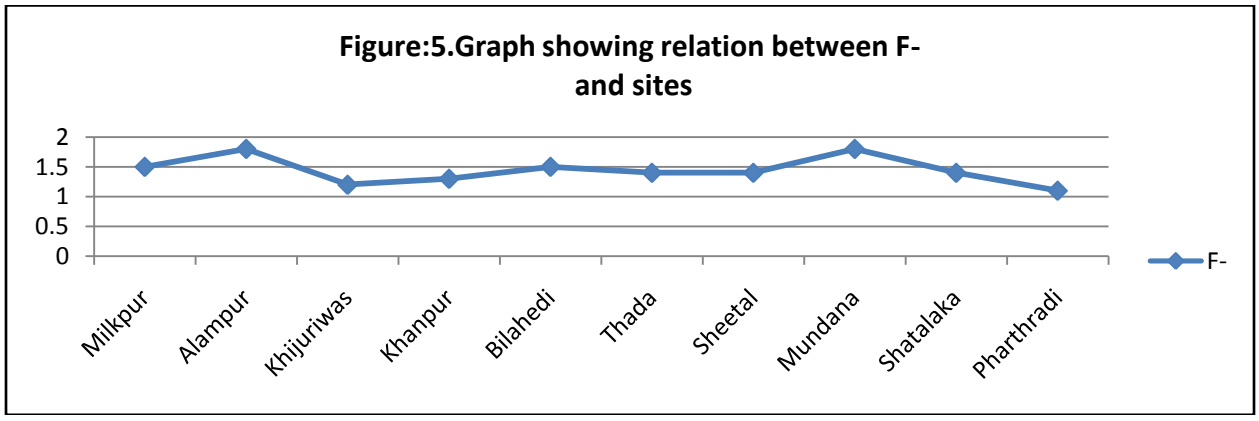
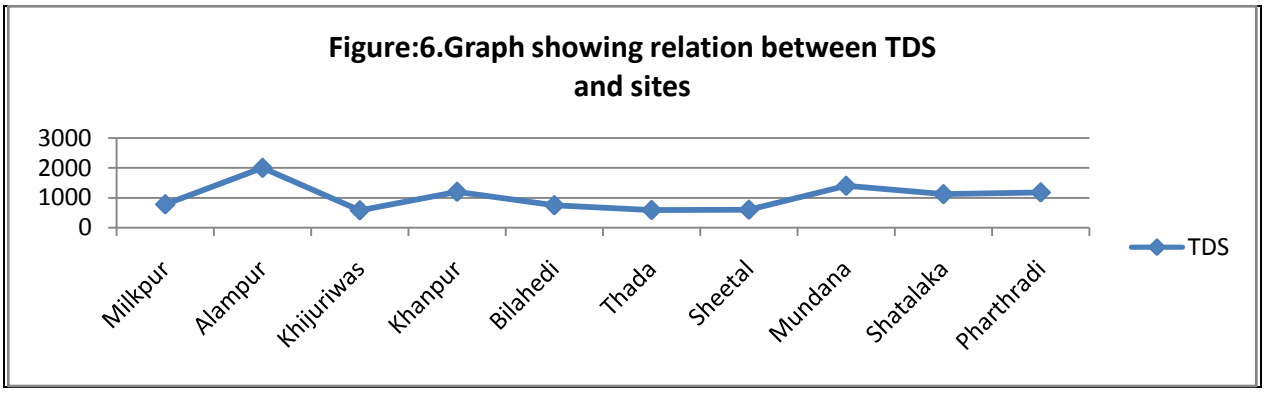
The fluoride concentration in the study area varies from 1.1 to 1.8 mg/l. About 10% sample crossed the permissible limit of 1.5mg/l. If the fluoride in drinking water is less than 0.5mg/l, the incidence of dental disease in children is likely to be high. However, when present in much greater quantities they can cause endemic cumulative fluorosis resulting skeletal damage. Result showed that ground water sample of village Alampur and Mundana contain more fluoride concentrations then permissible limit [12-13]





Nitrate (NO_3^-)

The nitrate value in the study area varies from 25 to 70mg/l. Increased level of nitrate at various locations may be attributed due to the surface disposal of sewage and agricultural wastes. Nitrate is effective plant nutrient and moderately toxic and is considered important for drinking water supplies [1,3,9]. Its concentration above 45mg/l proves detrimental to human health.

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Sulphate (SO_4^{-2})

High amount of sulphate cause laxative effect to the children in hot weather climates. In the all sample of studied area, sulphate concentration in drinking water is below the standard. [9].

Heavy metals and others

Heavy metals like Cd, Pb, Hg, As and Cr are not detected in most of the study area. In some study areas Cd, Pb and Cr are present in very low concentration. These heavy metals are in the permissible limits. The presence of these toxic heavy metals in organisms can cause many diseases even if present in very low concentration. Heavy metals not only cause phytotoxicity but also enter into the food chain resulting in toxicity in animals and may be carcinogenic in man. Chemical oxygen demand (COD) and Biological oxygen demand (BOD) are in normal range in all collected samples.

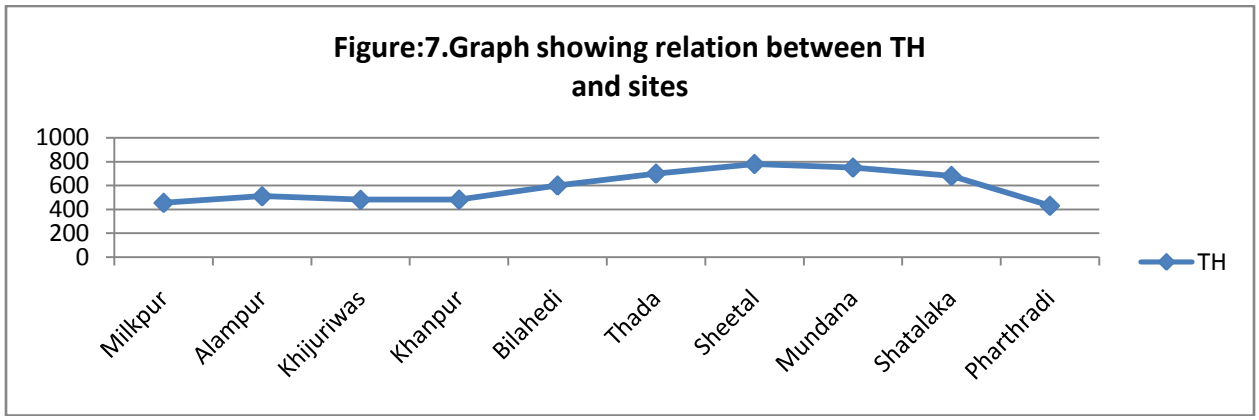

Figure:7.Graph showing relation between TH and sites

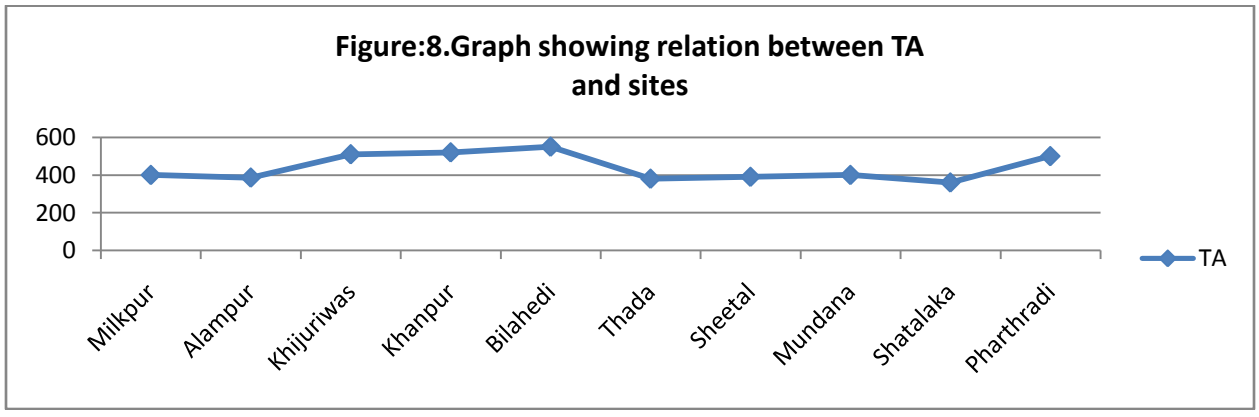

Figure:8.Graph showing relation between TA and sites

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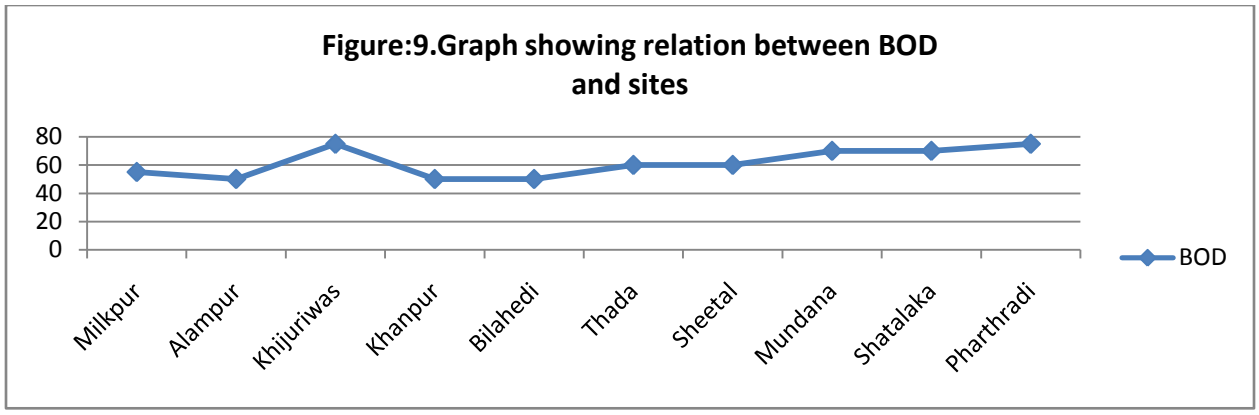

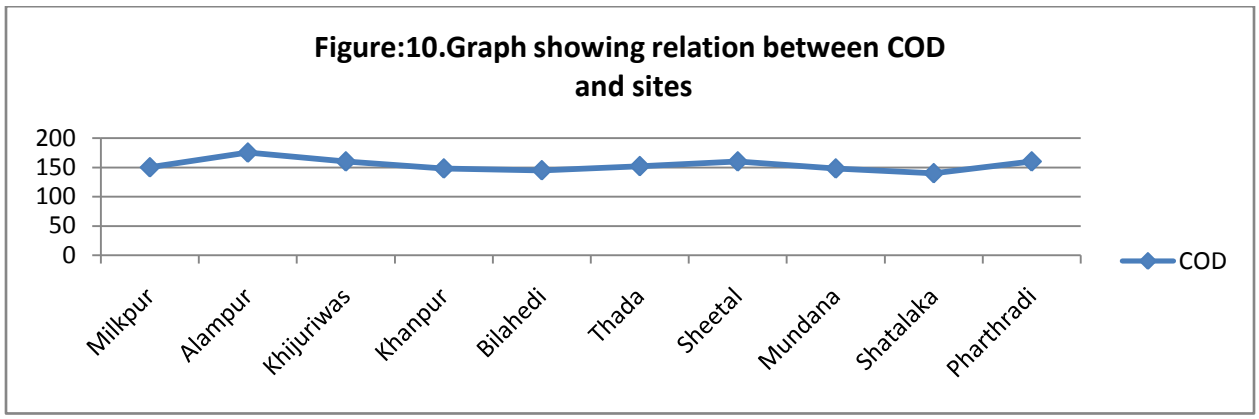

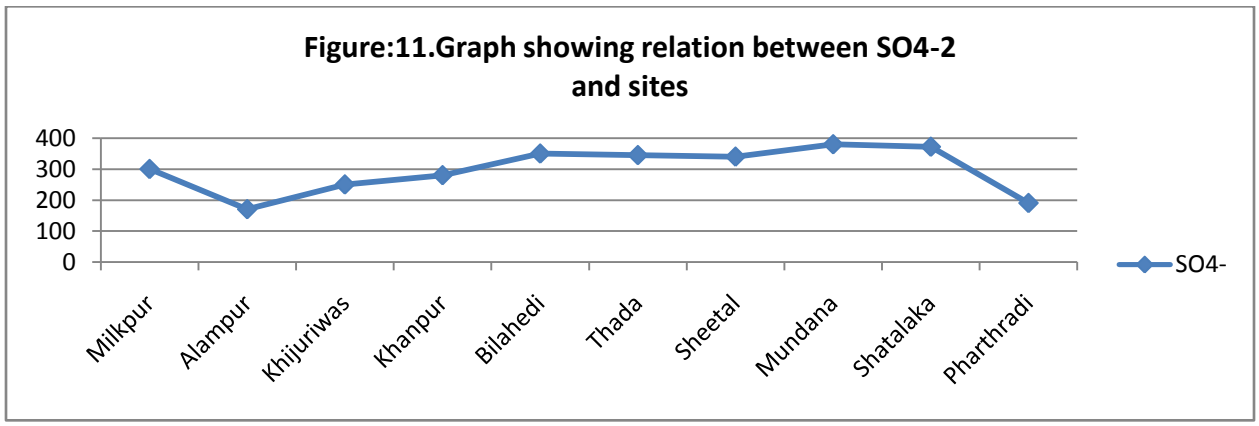

CONCLUSION & SUGGESTIONS

In view of the above it has been observed that, the samples of all the sites are slightly polluted and not suitable for direct consumption for drinking. But directly can be used for irrigation purposes. After the treatment like reverse osmosis, electrophoresis, ion exchange and

solar distillation etc. it can be used for drinking purposes. So our investigations are useful for government authorities, for taking care and reducing ground water pollution.

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