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Ground Water Quality Status of Northern and Eastern Zone of Bilaspur Urban Areas, Bilaspur Distt., C.g. (India)

KEYWORDS: water quality, urban, Physico-chemical parameter, public health and Statistical value

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ABSTRACT *Analytical studies of some selected physicochemical parameter with metallic elements were made on the underground water bodies of Northern and Eastern Zone of Bilaspur urban areas, Chhattisgarh. Water samples were collected from ten different selected spot in the month of Nov'2010 to Jan'2011. Temperature, pH, E.C, Turbidity, TDS and D.O etc. were analyzed instantly in the sampling spot while T.S, TSS, TH, Alkalinity, D.O, BOD, COD, Cl−, F−,SO42−, NO3−, PO43−, Na, K, Ca, Mg, Fe, Al by the standard method as per IS procedure. The statistical parameters like mean, SD, SE, Correlation coefficient and Water Quality Index were systematically calculated. It was observed that TS, TDS, TSS, Alkalinity, TH, DO, BOD, COD, Mg, Fe, and Al have higher value than maximum permissible limit of IS: 10500 and WHO standard of drinking water. The elevated values of these parameters are of great concern to public health when the water from these bore wells are consumed by people without treatment.*

1. Introduction:

Water is the essential for the survival of any form of life. On an average, a human being consumes about 2 litres of water every day (Pandey and Gupta, 2005). Water accounts for about 70% of the weight of a human body. About 80% of the earth's surface is covered with water. But, however, 97% of the earth's water resources are locked-up in the ocean and seas, which is unfit for human consumption and other uses because of its high salt content (De, 2000; Pandey and Gupta, 2005). Of the remaining 2% is trapped in giant glacier and polar ice-caps and only 1% is available as fresh water in rivers, lakes, streams, reservoirs and ground water which is suitable for human consumption (Dara, 2002). Owing to increasing industrialization on one hand and exploding population on the other, the demand of water supply have been increasing tremendously (Masters, 2004; Verma, 2000). Moreover, considerable part of this limited quantity of water is polluted by sewage, industrial wastes and a wide array of synthetic chemicals. Thus, the quality as well as the quantity of clean water supply is of vital significance for the welfare of mankind (Dhameja, 2006; Hammer and Hammer, 2000)

1.1. Study area:

Bilaspur city is the district head quarter of Bilaspur district, is the second largest city of Chhattishgarh state. It is situated on the banks of river Arpa. Bilaspur district is located between 21°47´ to 23°08´ North latitudes and 81°14´ to 83°15´ East latitudes, with a height of 262 meters from the sea level. The average rain fall in this area is 1220 mm. Many companies big small have their manufacturing/ production units are located in an around Bilaspur. Due to huge industrialization of Bilaspur city and its surrounding air, water and soil are continuously polluted, so it is necessary to analyze the extent of pollutant present in the water of this area (Imperial Gazetter of India, 1908-1931).

Fig. I: Location of study area

2. Material and Method:

In our study, we have selected ten sampling spots (shown in Fig.I) as the basis of environmentally significant, which were named NZ1, NZ2, NZ3 NZ4, NZ5, EZ1, EZ2 EZ3, EZ4 and EZ5. Ground water samples were collected 1st day of every month of the post monsoon season (Nov'2010 to Jan'2011). In two liter capacity of polyethylene jerry canes and (one for physical and chemical analysis and another for metal analysis) previously soaked with 8M HNO_3 and clean with detergent followed by rinsing with double distilled water. The collected water sample was preserved in ice cooled chamber and kept in dark room (De, 2006; Rand, 1976). Analysis was carried out by the standard protocol (Tyrrel, 2002; Warhate, 2006; Shrivastav, 2008; Orebiyi, 2010; APHA, 1995; Clesceri, 1991; WHO,1993; BIS, 1993; Verma, 2000; De, 2006; Rand, 1976; HACH, 2000; Allen, 1974; Vogel, 1978; Ewing, 1972) as per standard method within a short period of time, so as to get more reliable and accurate results.

3. Result and Discussion:

The results are given in the Table I while Statistical parameters-Mean, SD, SE, WQI and Correlation matrix are displayed in Table II – IV.

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Table I: Average value of Physico-chemical and metallic element analysis.

Parameters/ Sampling Spot	NZ1	NZ2	NZ3	NZ4	NZ5	EZ1	EZ2	EZ3	EZ4	EZ5
Temperature	19.766	19.7	19.666	20	19.8	19.8	19.9	19.86	19.8	19.83
PH	12.486	7.2	7.31	7.3	7.403	7.383	7.426	7.176	6.866	7.046
Conductivity	585.366	1705.667	1256.333	914.666	842.33	1847	1524	1599.33	2130.667	2250.667
Turbidity	17.366	17.333	16	13.333	17.66	27.666	22.333	30.33	27	29
TS	852.033	1130.333	1231.667	1096.333	1105.66	1228	1077	1486.333	1505	1438
TDS	770.033	1125.667	1298.667	1067.333	1141.667	1148	1286.333	1559.667	1430	1393.333
TSS	158.366	63.333	92	103.666	114.333	207	61.33	40.33	157.666	417.666
Alkalinity	121.133	243.933	342.8	338.4	458.733	350.233	397.733	504.966	608.8	659.133
Total Hardness	261.366	298.666	325.333	218	227	362.333	307.333	523.333	649.333	563.666
Chloride	94.066	219.353	191.016	158.706	162.116	151.73	133.763	198.236	247.333	203.333
Fluoride	0.28	0.35	0.45	0.446	0.376	0.403	0.316	0.26	0.65	0.796
Sulphate	107.933	142.233	171.633	169.466	171.5	166.8	165.566	196.266	230.1	163.7
D.O	10.8	8.666	8.933	4.9	5.266	11.36	7.033	5.433	7.133	5.466
BOD	3.196	5.046	5.73	3.703	6.736	5.21	7.8	3.643	5.516	8.06
COD	10.933	9.233	12.1	14.3	10.366	12.83	10.766	11.9	12.013	9.143
Nitrate	11.166	20.933	31.666	28.533	14.3	18.233	21.333	29.5	34	29.66
Phosphate	0.166	0.14	0.246	0.21	0.25	0.23	0.263	0.19	0.173	0.323
Sodium	21.666	20	47	40.66	57.66	79.333	65	89.333	91.33	119.333
Potassium	3	2.343	5.516	4.436	4.936	7.71	7.836	8.866	10.75	8.793
Calcium	8.823	7.84	6.033	7.056	5.64	8.473	7.506	11.25	8.916	15.36
Magnesium	33.483	17.766	34.933	5.26	19.003	22.876	5.723	4.833	85.653	43.23
Iron	0.783	1.316	0.023	0.023	0.463	0.366	0.77	0.963	1.87	2.143
Aluminum	0.023	0.133	0.046	0.02	1.383	0.543	0.71	0.114	0.766	0.576

* All parameters in mg/Lit. except Conductivity (μ mhos/cm), Turbidity (NTU) and P^H

NZ1– Koni, NZ2–Sarkanda , NZ3– Ashok Nagar, NZ4– Ram green City, NZ5 – Science College.

EZ1– Rajkishore Nagar, EZ2–Mopka , EZ3–Hemu Nagar, EZ4– Deorikhurd, EZ5–Lalkhadan.

Table II: Statistical Parameter of water Quality

Parameters	N	Range	MIN	MAX	SD	SE	%CV	Indian Drinking water Std. IS 10500:1993	WHO Rec.1993
Temperature	10	19.66-20	EZ3/Jan2011	NZ4/ Nov2010	0.095839	0.030307	0.4837	***	27-28
PH	10	6.86-12.48	EZ4/Nov2010	EZ1/ Jan2011	1.669878	0.528062	21.5192	6.5-8.5	6.5-8.5
Conductivity	10	585.36-2250.66	NZ5/Jan2011	EZ5/ Nov2010	557.1384	176.1826	38.0142	750 - 2250	1000.000
Turbidity	10	13.33-30.33	NZ4/Jan2011	EZ3/ Jan2011	6.221953	1.967554	28.5367	5- 25 NTU	5 – 25 NTU
TS	10	852.03-1505	EZ2/Dec2010	EZ4/ Nov2010	208.6705	65.9874	17.174	520-2050	
TDS	10	770.03-1559.66	EZ1/Dec2010	EZ4/ Nov2010	222.6256	70.40041	18.217	500-2000	1000.000
TSS	10	40.33-417.66	EZ3/Nov2010	EZ5/ Nov2010	109.7953	34.72033	77.5555	20-50	
Alkalinity	10	121.13-659.13	NZ1/Jan2011	EZ5/ Nov2010	162.2138	51.29651	40.2928	300-600	
Total Hardness	10	218-649.33	NZ4/Nov2010	EZ4/ Nov2010	151.0469	47.76521	40.4261	300-600	500.000
Chloride	10	94.06-247.33	NZ1/Jan2011	EZ3/ Nov2010	44.73735	14.14719	25.4239	200-1000	200-1000
Fluoride	10	0.26-0.79	EZ3/Jan2011	EZ5/ Nov2010	0.169192	1.045565	763.5949	1-1.2	1.500
Sulphate	10	107.93-230.1	NZ1/Jan2011	EZ4/ Nov2010	31.58426	9.98782	18.7421	200-400	250.000
D.O	10	4.9-11.36	EZ5/Nov2010	EZ1/ Dec2010	2.351411	0.743582	31.3521	5.000	
BOD	10	3.19-8.06	NZ1/Dec2010	EZ5/ Nov2010	1.689299	0.534203	30.915	5.000	
COD	10	9.14-14.3	NZ2/Jan2011	EZ4/ Nov2010	1.599571	0.505829	14.0823	10.000	
Nitrate	10	11.16-34	NZ1/Dec2010	EZ4/ Jan2011	7.818781	2.472516	32.669	45	50
Phosphate	10	0.14-0.32	NZ1/Dec2010	EZ5/ Dec2010	0.054451	0.017219	24.8257	0.1	
Sodium	10	20-119.33	NZ1/Jan2011	EZ5/ Nov2010	32.11253	10.15487	50.8646	75-200	200
Potassium	10	2.34-10.75	NZ2/ Nov2010	EZ4/ Jan2011	2.774974	0.877524	43.2306	10	

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Calcium	10	5.64-15.36	NZ5/Jan2011	EZ5/ Nov2010	2.836244	0.896899	32.6355	75-200	200
Magnesium	10	4.83-85.65	EZ3/Jan2011	EZ4/ Nov2010	24.47433	7.739463	89.7251	30-100	
Iron	10	0.02-2.14	NZ3/ Nov2010	EZ4/ Nov2010	0.722609	0.228509	82.8362	0.1-1.0	0.1-1.0
Aluminum	10	0.02-1.38	NZ4/ Nov2010	NZ5/ Jan2011	0.447585	0.141539	103.6636	0.03-0.2	0.03-0.2

Table III: Correlation Matrix of water Quality

	Temp.	PH	Cond.	Turb.	TS	TDS	TSS	Alk.	T H	Cl-	F-	SO42-	D.O	BOD	COD	NO3-	PO43-	Na	K	Ca	Mg	Fe	Al
Temp.																							
PH	-0.159																						
Cond.	-0.075	-0.612																					
Turb.	0.0999	-0.295	0.763																				
TS	0.0352	-0.675	0.7936	0.7513								Significant at 5% level, r > 0.649											
TDS	0.0947	-0.752	0.7054	0.676	0.9111																		
TSS	0.0076	0.0136	0.452	0.4139	0.2806	0.0485																	
Alk.	0.2521	-0.661	0.6818	0.6713	0.8563	0.8255	0.4511																
T H	-0.029	-0.346	0.8086	0.8293	0.891	0.7505	0.4194	0.7708															
Cl-	-0.23	-0.711	0.7031	0.3508	0.8119	0.7129	0.0852	0.6291	0.6777														
F-	0.0193	-0.383	0.6216	0.3274	0.5669	0.3676	0.7949	0.7029	0.6078	0.5423													
SO42-	0.2135	-0.718	0.5307	0.4853	0.8181	0.8068	-0.0723	0.771	0.663	0.6965	0.3858												
D.O	-0.587	0.5086	-0.065	-0.066	-0.391	-0.499	-0.0065	-0.631	-0.1892	-0.3424	-0.282	-0.4648											
BOD	-0.049	-0.463	0.4587	0.2453	0.2229	0.3739	0.4261	0.5536	0.1932	0.1855	0.504	0.1771	-0.2646										
COD	0.4488	-0.076	-0.249	-0.149	0.0165	-0.04	-0.3	-0.122	-0.1278	-0.1487	-0.157	0.3277	0.0254	-0.528									
NO3-	0.1359	-0.631	0.5607	0.3022	0.7843	0.7612	0.096	0.6306	0.6507	0.7411	0.5642	0.7272	-0.4392	0.1056	0.2726								
PO43-	0.2148	-0.315	0.2248	0.2384	0.1956	0.3016	0.5872	0.5223	0.0966	-0.0997	0.4912	0.0742	-0.3338	0.7686	-0.1701	0.1509							
Na	0.2585	-0.496	0.7327	0.8641	0.8203	0.759	0.5895	0.9102	0.8026	0.4183	0.6335	0.6264	-0.3777	0.4921	-0.0702	0.5036	0.5872						
K	0.263	-0.479	0.7103	0.8388	0.8134	0.7957	0.3172	0.8356	0.8382	0.4312	0.492	0.7885	-0.2726	0.373	0.1264	0.583	0.3705	0.9078					
Ca	0.1565	-0.043	0.606	0.7193	0.5475	0.4067	0.7186	0.5382	0.6935	0.2572	0.5402	0.0645	-0.2089	0.1928	-0.3643	0.3071	0.3338	0.6958	0.4843				
Mg	-0.369	0.0073	0.4348	0.2779	0.4245	0.1836	0.4378	0.4036	0.6472	0.4879	0.6742	0.4052	0.1576	0.1513	-0.103	0.3613	-0.065	0.3411	0.4353	0.2218			
Fe	-0.096	-0.127	0.7065	0.6007	0.5387	0.4029	0.535	0.5734	0.766	0.5454	0.6031	0.2339	-0.1908	0.3496	-0.6175	0.2804	0.0433	0.5415	0.4606	0.7414	0.5762		
Al	0.062	-0.311	0.1582	0.2318	0.1407	0.1873	0.1985	0.5077	0.1052	0.0832	0.2437	0.3454	-0.2916	0.658	-0.2959	-0.2176	0.4107	0.3994	0.3509	-0.099	0.2135	0.2046	1

P^H : In our investigation P^H ranges was noted 6.84 at the sampling spot EZ4 (Nov'2010) to 7.53 at the Site of EZ1 (Jan'2010). The above ranging P^H indicate water is slightly neutral to basic in nature, which is under the range of acceptable for drinking water suggested by WHO, 1993 and BIS, 1991.

Electrical Conductivity: For good aquatic life (Ellis, 1937) the conductivity value of 150-500 µS cm-1. Minimum conductivity was observed 763 µ mhos/cm at the sampling site NZ5 in the month of January' 2011, while maximum EC was found on the sampling point EZ5; 2351 µ mhos/cm, which is slightly above the maximum permissible level as per BIS, 1991 standard. Turbidity : It was detected 12 NTU as low on the investigation site NZ4 in the month of Jan'2011 which is within permissible limit while 33 NTU reported as the higher value on the EZ3 in Jan'2011. The Maximum value was beyond the acceptable range i.e., 5-25 NTU as set by WHO, 1993 and BIS, 1991.

Suspended and Dissolved Solid : TS was noted in the ranges from 1093 to 1988 mg/L on the sampling point EZ2 (Dec-2010) and EZ4 (Nov 2010) respectively. TDS only measure of filtrate water sample. 1026 mg/L on the sampling spot EZ1 in the month of Dec 2010 and 2030 mg/L of the location site EZ4 in the month of Nov 2010. TSS was noted in the ranges from 12 to 427 mg/L on the sampling point EZ3 (Nov-2010) and EZ5 (Nov 2010) respectively. The TSS value was within the permissible unit while Maximum values of TS and TDS crossed the maximum allowable limit. Although high suspended dissolved particles have not serious health hazard, but those peoples who are suffering from kidney and constipation problems mere affected of these parameters.

Alkalinity : The cause of alkalinity in water is due to the presence of various dissolve ions such as OH^-, HCO_3^-, PO_4^{3-}, BO_3^- etc (Sharma, 2004; Garg, 2008). In our study minimum and maximum both values were noted in Jan' 2011 as 162.3 mg/L at the sampling location NZ1 and 664.7 mg/L of the sampling spot EZ5 (Nov'2010).

Total Hardness : The sources of hardness of water is chiefly due to the dissolve of OH^-, HCO_3^-, Cl^- and SO_4^- ion of Ca^{2+}, Mg^{2+}, Fe^{2+} and Mn^{2+} (Shrinivasa et al., 2000). In study region its ranges was recorded 220 mg/L to 708 mg/L from sampling point NZ4 (Dec'2010) and EZ4 (Nov'2010). The highest value was crossed the ranges according to WHO, 1993 and BIS, 1991 standard drinking water; 300-600 mg/L hardness of water does not create adverse effect on human health.

DO : Dissolve oxygen is important water quality parameter which determine organic pollution of water (Mahammad et al., 2010). According to various water monitoring agencies its desirable value is 5 mg/L. In our study 3.5 mg/L to 13.3 mg/L reported as low and high values at the sampling spot EZ5 (Nov'2010) and EZ1 (Dec'2010).

BOD : It was noted on ranging from 1.58 mg/L on the sampling point NZ1 in the month of Dec-2010 to 10.81 mg/L in the month of Nov-2010 at the sampling point EZ5. Some water samples were showed above the permissible limit prescribed by ISI, 1993, 5mg/L.

COD: The ranging was obtained from 2.6 mg/L (NZ2) in the month of Jan'2011 to 21.60 mg/L (EZ4) in the month of Nov 2010. The higher value is too hold greater than the above permissible value according to standard drinking water agency as per BIS, 1991; 10mg/L. The high value may cause the presence of high content of carbonaceous particle and suspended particles in different water bodies.

Chloride : The potentially of Cl^- in microbes killing is depended upon the P^H and people accustomed to higher

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chloride in water are subjected to laxative effect (Dahiya and Kaur, 1999). In our minor assessment the ranging was found at 26.12 mg/L to 299.29 mg/L from NZ1 (Jan'2011) and EZ3 (Nov'2010) respectively within under the desirable limit.

Fluoride : Its desirable amount 1 to 1.5 mg/L is useful for human being. Its concentration is increased beyond the permissible limit 1 to 1.5 mg/L causes health hazardous. In this work ranging was obtained 0.22 mg/L to 0.89 mg/L from EZ3 (Jan'2011) and EZ5 (Nov'2010) respectively.

Sulphate : The minimum and maximum value was calculated at 93.40 mg/L and 396.3 mg/L from NZ1 (Jan'2011) and EZ4 (Nov'2010) respectively.

Nitrate : In study area minimum value was recorded 11.1 mg/L on the sampling point NZ1 in the month of Dec (2010) while 30.5 mg/L on the location spot EZ4 in the month of Jan-2011. The highest value is below the permissible level as per standard agency. Its high value causes 'blue baby disease' in children (Patil et al, 2011).

Phosphate : Domestic sewage and chemical fertilizer are chief source of phosphate in water. In this research work phosphate was obtained in the range of 0.11 mg/L from NZ1 sampling point in the month of Dec-2010 to 0.36 mg/L on EZ5 in the month of Dec-2010.

Sodium : Domestic sewage is chief source for increase the amount of sodium in water. In our investigation observed value was 19 mg/L to 121 mg/L from NZ1 (Jan-2011) and EZ5 (Nov-2010) respectively.

Potassium : Its permissible range in drinking water is 10mg/L as per BIS, WHO and ICMR standard. 1.21mg/L was detected as minimum on sampling spot NZ2 in the month of Nov'2010 while 11.13 mg/L at the sampling spot EZ4 in the month of Jan'2011.

Calcium : Its compound makes water hard due to high dissociation in water. In our research work the ranging was observed from 5.23 mg/L to 16.00 mg/L from NZ5 (Jan-2011) and EZ5 (Nov-2010) respectively. The range was under permissible according to standard value.

Magnesium : 472 mg/L was reported on the sampling spot EZ3 in the month of January'2011 while 87.84 mg/L was noted on the sampling location EZ4 in the month of Nov'2010.

Iron : In our study 0.01 mg/L (NZ3, Nov-2010) to 2.21 mg/L (EZ5, Jan-2011 and Dec-2011) were reported. The amount of iron is high which is above the permissible limit as per drinking water standard.

Aluminium : In our study minimum amount was detected as 0.02 mg/L on the sampling spot NZ4 in the month of Nov-2010 while 1.99 mg/L was reported in the month of Jan-2011 on the sampling location NZ5.

Correlation Matrix : The value of 'r' was calculated on the monthly basis as follows:

253 correlation coefficient 'r' among various water quality parameters were observed in which 182 positive (+) while 71 negative (–) correlation. Higher positive correlation was seen between TDS and TS (r = 0.911) while minimum positive r value was detected between Mg and P^H (r = 0.0073). Near about 53 correlations were found above the significant at 5% level (r > 0.649).

Strong positive correlation was calculated between turbidity and EC (r =0.763); TS and EC(r =0.793); TS and turbidity (r =0.751); alkalinity and TS (r =0.856); alkalinity and TDS (r =0.825); TH and EC (r =0.808); TH and turbidity (r =0.829); TH and TS (r =0.890); TH and TDS (r =0.750); TH and alkalinity (r =0.770); Cl^- and EC (r =0.703); Cl^- and TS (r =0.811); SO_4^{2-} and TS (r =0.818); SO_4^{2-} and TDS (r =0.808); SO_4^{2-} and alkalinity (r =0.770); $NO3^-$ and TDS (r =0.761); Na and alkalinity (r =0.910); Na and turbidity (r =0.864); Na and TS (r =0.820); Na and EC(r =0.732); K and turbidity (r =0.838); K and TH (r =0.838); K and alkalinity (r =0.835); K and TDS (r =0.795); K and SO_4^{2-} (r =0.788); Ca and turbidity (r =0.719); Ca and TSS (r =0.718); Fe and TH (r =0.766); Fe and EC (r =0.706) etc.

Negative correlation were observed between TS and P^H (r = – 0.675); alkalinity and P^H (r = – 0.660); TDS and P^H (r = – 0.751); Cl^- and P^H (r = – 0.711); SO_4^{2-} and P^H (r = – 0.717); DO and alkalinity (r = – 0.631) etc.

The minimum negative correlations was detected between Fe and F^- (r = – 0.013).

Water Quality Index: Water quality index was calculated for different sampling locations, the results were found in the ranges of 87.6 at the sampling point NZ4 to 1943.871 at the NZ5. The high value of this statistical parameter indicated high loading of various kinds of pollutant. Another investigating points such as EZ4 (1119.151), EZ2 (1038.858), EZ5 (884.126) and EZ1 (803.586) showed many folds greater than maximum WQI (>100) indication of intrusion of pollutants through leaching or percolation of surface water via domestic garbage.

Table IV: Water Quality Index

Sampling Spot	∑QiWi	∑Wi	WQI=∑QiWi/∑Wi
NZ1	38834.356	402.1025	96.5841
NZ2	100259.112	402.1025	249.337
NZ3	51112.660	402.1025	127.113
NZ4	35224.250	402.1025	87.6
NZ5	781635.521	402.1025	1943.871
EZ1	323124.119	402.1025	803.586
EZ2	417727.564	402.1025	1038.858
EZ3	90719.443	402.1025	225.612
EZ4	450013.696	402.1025	1119.151
EZ5	355509.611	402.1025	884.126

4. Conclusion:

We have taken minor but deeply month wise monitoring of Ground water in the two zone of Bilaspur urban areas EZ and NZ. From the results of experiment it may be concluded that the Ground water of EZ are slightly polluted in references of EC (2250.667 µ mhos/cm), turbidity (30.33), TDS (1559.667 mg/L), alkalinity (659.133), Total Hardness (649.333), COD (12.013), Phosphate (0.323). These qualities were marginally higher than the standard values of drinking water. Higher Positive correlation of significant was calculated out between TDS vs. TS (r = + 0.911) indication that of both parameters are significantly correlated and follow similar kind of pattern together (increasing or decreasing). WQI reported 1943.871 for the sample site NZ5, more loading pollutant in this water source. We have suggested to peoples by comparing prior treatment is necessary before human Consumption for especially portable purpose.

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REFERENCE

1. Allen, S. E, Grimshaw, H. M, Parkinson, J. A, Quarmby, C.(1974) Chemical Analysis of Ecological Materials. Blackwell Scientific Publishing, Oxford, 314. | 2. APHA, AWWA and WPCF. (1995) Standard Methods for the Examination of Water and Wastewater, 19th ed. American Public Health Association/American Water Works Association/ Water Environment Federation, Washington DC, USA. | 3. Agarwal D. C, Gupta Sonendra, Jha Manoj. (2006) Shree Sai's Advance Mathematics, 1st ed., pp. 171-245. | 4. Bhattacharjee K. K, Bhattacharya K. G. (2010) Baseline study of Siang river water in pasighat, Arunachal Pradesh (India). Journal of Environmental Science and Engineering. 52(2), 121-130. | 5. Orebiyi E.O. et al. (2010) Assessment of Pollution Hazards of Shallow Well Water in Abeokuta and Environs, Southwest, Nigeria. American Journal of Environmental Sciences. 6 (1), 50-56. | 6. Ellis M. M. (1937) Detection and Measurement of Stream Pollution. U. S. Bur. Fish Bull., Wshington, 22, 367- 437. | 7. BIS, Indian Standard, Drinking Water- Specification. (1991) 1st Revision, Bureau of Indian Standards, IS: 10500, New Delhi. | 8. Clesceri, L.S., A.E. Greenberg, A.D. Eaton.(1991) Standard Methods for the Examination of Water and Wastewater, 20th ed., American Public Health Association, USA, pp. 1325. | 9. De A. K. (2000) Environmental Chemistry, 4th ed, New Age International (P) Ltd, New Delhi , pp. 52-53. | 10. Dara S. S. (2002) A Text Book of Environmental Chemistry and Pollution Control, 4th ed, S Chand & Co. Ltd., New Delhi, pp. 65-66. | 11. Dhameja Suresh K. (2006) Environmental Studies, 3rd ed, S. K Kataria & Sons, New Delhi, pp. 6-7. | 12. De A. K. (2006) Environmental Chemistry 6th ed , New Age International (P) Ltd, New Delhi, pp 207-208. | 13. Dahiya Sudhir , Kaur Amarjeet. (1999). Physicochemical characteristic of underground water in rural areas of Tosham subdivisions, Bhiwani district, Haryana. Journal of Environmental Pollution. 6(4), 281. | 14. Ewing, G. W. (1972). Instrumental methods for chemical analysis, 1st Ed. Edgard Blucher, São Paulo, Brasil, pp. 296. | 15. Garg D et al., (2008). Analysis of water quality of Bharatpur area in post monsoon season, January 2007. Rasayan Journal Chemistry. 1(4), 743-750. | 16. Hammer Mark J, Hammer Mark J, Jr., (2000) Water and waste water Technology, 3rd ed, Printice Hall of India Pvt Ltd, New Delhi, pp 137-154. | 17. HACH., (2000). Spectrophotometer Handbook DR/2010. Procedure Manual, Hach Company, UK. | 18. Imperial Gazetter of India, (1908-1931) Oxford, vol.8, p. 221-224. | 19. ISI., (1993) Specification for Drinking water IS: 10500, New Delhi. | 20. Masters Gilbert M., (2004) Introduction to Environmental Engineering and Science, 2nd ed., Pearson Education, pp 220-221. | 21. M. Aqeel Ashraf, M. Jamil Maah , Ismail Yusaff. (2010) Water quality characterization of Varsity Lake, University of Malaya, Kualalumpur, Malaysia. E-Journal of Chemistry. 7(S1), S245 - S254. | 22. Pandey Piyush Kant, Gupta Deepti. (2005) Environment and Ecology, 2nd ed, Sun India publications, New Delhi, pp 4.1- 4.5. | 23. Patil V. T , Patil P. R. (2011) Ground water quality of open wells and tube wells around Amalner town of Jalgaon District, Maharashtra, India. E-Journal of Chemistry. 8(1), 53-58. | 24. Rand, M. C, Greenberg, Taras. (1976) Standard methods for examination of water and waste water, American Public Health Association, 14th ed., Washington D.C. USA, pp 42-43. | 25. Shrivastav, S. K et al. (2008) Study of physicochemical quality of pond water in Bilaspur, Chhattisgarh. Current World Environment, 3(1), 97-107. | 26. Sharma M. R. (2004) Assessment of ground water quality of Hamirpur area in Himachal Pradesh. Pollution Research. 23(1), 131-134. | 27. Shrinivasa Rao B and Venkateswarlu P. (2000) Physicochemical Analysis of selected ground water samples. Indian Journal Environmental Protection, 20(3), 161. | 28. Tyrrel, S.F et al. (2002) Removal of ammonical nitrogen from landfill leachate by irrigation onto vegetated treatment plane. Water Research, 36(1), 291-299. | 29. Verma, R.M. (2000) Analytical Chemistry Theory and Practice. 3rd (ed), CBS Publisher and Distributors, New Delhi, 465-491. | 30. Vogel, A.I. and J. Bassett. (1978) Textbook of Inorganic Analysis. 4th Edn, Longman, London, ISBN: 10:0582463211, pp: 962. | 31. Warhate, S. R et al. (2006) Impacts of Mining activities on Water and Soil. Journal of Environmental Science and Engineering. , 48 (2), 81-90. | 32. World Health Organization (WHO). (1993) Guidelines for Drinking-Water Quality (Vol. 1). 2nd ed., World Health Organization, Geneva, ISBN: 10: 9241545143, pp: 36. |