Correlation Analysis and Quality Assessment of Underground Drinking Water in Korba and Its Surrounding Industrial Areas

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Abstract

The investigation presents the statistical treatment of underground water samples collected from three stations in Korba (Chhattisgarh) and its surrounding industrial areas during the period 2014-2015. Correlation studies recorded indicate strong negative correlation between temperature and dissolved oxygen at all the stations for the entire study period. The concentration of calcium and magnesium salts increases with increase in pH as shown by strong positive correlation observed between pH and total hardness. pH showed strong positive correlation with total hardness, chloride , fluoride at S-3 (Anand Nagar) indicating that the calcium salts were affecting the pH of the water samples. Strong negative correlation of electrical conductivity with magnesium hardness and nitrate indicates that as the concentration of electrical conductivity increase the concentration of these ions also increases. Total solids and total dissolved solids showed highly positive correlations with total hardness, chloride, sulphate and COD at S-1 (Pandari Pani). In the correlation study, it was found at sampling stations that total hardness correlated with calcium hardness, magnesium hardness, chloride, sulphate. This indicates that hardness is mainly due to Cl^- and SO_4^{--} salts of calcium and magnesium. BOD was found to have positive correlation with COD & fluoride at S-3 and with fluoride at S-2 (Indra Nagar) .In the same period BOD showed highly negative correlation at S-1 with chloride. COD was strong positively correlated with phosphate and Strong negatively correlated with chloride at S-1.

Sulphate showed positive correlation with phosphate and chloride exhibited strong positive correlation with sulphate at S-2; with fluoride with nitrates at S-3. Correlation data recorded above indicate that nitrate, sulphate, fluoride, phosphate anions coexist in these water bodies along with chloride. Fluoride exhibited strong positive correlation with phosphate at S-1, S-2 and with nitrate at S-3.

KEYWORDS: Underground water, Physico-chemical parameters, Korba

Introduction

The importance of water for the existence of human society is because of its remarkable physical properties. The polarisation of the water molecule accounts for the unusual ability of water to act as a solvent for polar compounds. Water can dissolve and carry substances ranging from nutrients to industrial and domestic wastes[1] Water is said to be polluted when it is changed in its quality or composition directly or indirectly as a result of waste disposal and other human activities so that it becomes less suitable or harmful for drinking, domestic, agricultural, fisheries or other purposes. Normally water is never pure in a chemical sense. Even in the most unpolluted geographical areas, rainwater contains dissolved carbon dioxide, oxygen and nitrogen and may also carry in suspension dust or other particles picked up from the atmosphere. Theoretically, pure water is characterised by its conductivity as low as possible, the limit being dictated by the dissociation constant of water at that temperature. Temperature, turbidity and total suspended solids in rivers can be greatly affected by human activities such as agriculture, deforestation and the use of water for cooling. For example, the upward trend in soil erosion and the related increase in total suspended solids in rivers can be seen in most of the mountainous regions in India . To ascertain suitability of water for consumption, a large number of parameters signifying the quality of waters in various uses have been proposed. A regular monitoring of some of them not only prevents diseases and hazards but also checks the water resources from going further polluted. Purohit, S.S. has suggested the water quality parameters are roughly divided into three categories (i) Physical (ii) Chemical (iii) Biological [2]. In the Physical characteristics of water colour, odour, taste, temperature and turbidity are the physical factors of importance that determine the quality of water. Chemical characteristics tend to be more specific in nature than some of the physical parameters and are thus more useful in assessing the properties of a sample. It is useful at this point to set out some basic chemical definitions. The acceptable standards of physical, chemical and biological quality of water are prescribed by ICMR, WHO, USPHS and ISI. Such standards decide the status of drinking water quality of a particular area. However these standards are subject to continuous appraisal and revision. I.Durmishi, B.H.etal [3] reported the quality of drinking water is a crucial factor for human health. The objective of this study was the assessment of physical, chemical and bacteriological quality of the drinking water in the city of Tetova and several surrounding villages in the Republic of Macedonia for the period May 2007-2008. A total of 415 samples were taken for chemical, physical and bacteriological analysis.

A survey of literature shows that there is no systematic study of quality of underground drinking water in Korba and its surrounding industrial areas. Hence it is proposed to investigate the quality of underground water in Korba and its surrounding industrial areas. For this purpose various sampling stations have been selected which are having hand pumps. From these hand pumps, water samples will be collected every third months for a period of one year. Although the Hasdeo river caters the water requirements of a majority of the population, still a significant population residing in the suburbs are using underground (handpump water) water for bathing, drinking and other domestic purposes. Hence it was strongly felt that the water quality assessment of these hand pumps situated in different areas is very much essential. The following sampling sites in Korba city and its surrounding industrial areas were selected for assessing their water quality : Pandari Pani (Near IBP) S-1, Indara Nagar (Sumedha village) S-2 a residential area, Ananad Nagar (Near Sura Kachar mines) S-3, These sampling stations are located at different corners of Korba city covering a large area of Korba and its suburbs. People residing near these stations use hand pump water for bathing, washing clothes and drinking.

METHODOLOGY

Water samples were collected from three hand pumps located in residential and industrial area in Korba with necessary precautions. From these hand pumps water samples have been collected every three months for a period of one year in pre-cleaned polythene bottles of good quality of one liter capacity. The analysis of the following physico-chemical parameters was carried out : pH, temperature, electrical conductivity, oxidation-reduction potential (ORP), total hardness, calcium hardness, magnesium hardness, total solids, total dissolved solids, total suspended solids, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), fluoride, chloride, phosphate sulphate and nitrate. Parameters such as pH, temperature, conductivity, oxidation-reduction potential, dissolved oxygen were measured at the sample collection site using a portable kit (water quality analyser). Determination of other parameters such as hardness, total dissolved solids, total suspended solids, DO, BOD, COD, sulphate, phosphate, nitrate, chloride and fluoride were carried out by standard methods as prescribed by APHA (1989) [4], Manivaskam (2000) [5] Trivedi and Goel (1986) [6] and NEERI manual[7] on water and waste water analysis. The Nitrate and Phosphate were analyzed by the U.V.Visible Spectrophotometer. Total dissolved solid and Total suspended solid were estimated by calculation method. Dissolved Oxygen and Biochemical Oxygen Demand were estimated by Winkler's Method Reagents used for the present investigation were of A.R. grade and double distilled water was used for preparing various solutions.

Coefficient of Correlation (r):

The mathematical models used to estimate water quality require two parameters to describe the realistic groundwater situations. Correlation analysis measures the closeness of the relationship between chosen independent and dependent variables. This analysis attempts to establish the nature of the relationship between the variables and thereby provides a mechanism for prediction of forecasting. In this study, the relationship of water quality parameters on each other in the data of water analyzed was determined by calculating correlation coefficient, R, by using the formula as given.

To find the relationship between two parameters x and y, the Karl Pearson's Correlation Coefficient, r is used and it is determined as follows –

$$r = \frac{n \Sigma x y - \Sigma x \ \Sigma y}{\sqrt{[n \Sigma x^2 - (\Sigma x)^2] [n \Sigma y^2 - (\Sigma y)^2]}} \quad \text{----------------(1)}$$

here, n = number of data points ; x = values of x–variable ;
y = values of y–variable

To evaluate the straight–line by linear regression, following equation of straight line can be used $y = a x + b$ ……………………………(2)

here, y = dependent variable ; x = independent variable ;
a = slope of line; b = intercept on y–axis

$$a = \frac{n \Sigma x y - \Sigma x \Sigma y}{n \Sigma x^2 - (\Sigma x)^2} \qquad (3)$$

and $b = y - a x$ ……………………………………(4)

Here, x = mean of all values of x ; y = mean of all values of y

The correlation among the different parameters will be true when the value of correlation coefficient (r) is high and approaching to one. Correlation, the relationship between two variables, is closely related to prediction. The greater the association between variables, the more accurately we can predict the outcome of events [8, 9, 10].

RESULTS AND DISCUSSION

Physico-Chemical characteristics of water samples collected from sampling stations S-1, S-2, S-3 during 2014-2015 are listed in Tables 1, 2 and 3.

Temperature of a water source is a physico-chemical property that has direct or indirect influence on many other characteristics of water. Temperature measurements give an idea about the biochemical activity in the water body. The parameter of temperature is also important for the study of limnology of the water body.

A perusal of correlation tables 4,5 and 6 for 2014-2015 revealed that temperature had strong negative correlation with dissolved oxygen at all the stations, At S-1 temperature had maximum negative correlation with DO (r = - 0.998). This is indicative of the temperature dependence of dissolved oxygen levels. During 2014-2015, temperature showed positive correlation with oxidation-reduction potential at S-2 (r = 0.936).pH is one of the important factors in water quality management. At a given temperature the intensity of the acidic or basic character of a solution is indicated by its pH. It plays an important role in corrosively, efficiency of chlorination and in other treatment processes.

In the assessment year 2014-2015, pH had positive correlation with total dissolved solids at S-2 (r = 0.709), with total hardness (r = 0.990),with chloride (0.919)with fluoride(0,990), at S-3. During this period pH had negative correlation with many parameters at different sampling stations. We have reported here some of the strong negative correlations which pH exhibits with different parameters. pH had strong negative correlation with sulphate at S-1 (r = - 0.992).

Strong positive correlation observed between pH and total hardness showed that the concentration calcium and magnesium salts increases with increase in pH. The increase in BOD with rise in pH at some of the stations may be due to accumulation of biomass in these waters at an elevated pH. Similarly positive correlation observed between pH and chloride, fluoride, nitrate and phosphate at many sampling stations during the study period may be due to the presence of salts of these anions which may be slightly alkaline in aqueous solution. Results similar to the present study were observed in Tamil Nadu by Vijayram, K. et al.[11]

Electrical conductivity (EC) measurement is important in determining whether water contains an appreciable amount of dissolved ions or solids. The value of EC depends upon the total concentration of ionised substances. Electrical conductivity also checks the reliability of mineral analysis and quality of distilled water. During 2014-2015, electrical conductivity showed strong positive correlation with total dissolved solids at S-1(r = 0.902) .

Strong negative correlation of electrical conductivity with magnesium hardness at S-2 (r = -0.972) and nitrate (r= - 0.954) at S-3. It indicates that as the concentration of electrical conductivity increase the concentration of these ions also increases. These results are quite similar to those observed by Tyagi, P. et al.[12] Negative correlations of electrical conductivity with BOD and COD can be attributed to the non-ionic nature of biomass and other organic oxidisable matter present in water.

ORP is strong positively correlated with TDS at S-1(r = 0.934) and strong negative correlated with total solids(r=-0.971) at S-2 . Redox potentials of the water samples in the study area had positive values which imply that the entire waters system was completely oxidizing. Total dissolved solids are one of the important factors in water quality management which shows the various kinds of minerals present in water sample.

In the sampling year 2014-2015, total dissolved solids had strong positive correlation with total solids at S-3 (r = 0.901), with chloride S-1 (r = 0.965), During this period total dissolved solids had strong negative correlations with total hardness at S-1 (r = - 0.919).

During the present study in 2014-2015, total suspended solids showed strong positive correlation with COD (r = 0.992) at S-2 with phosphate (r = 0.934), at S-3. Total suspended solids showed strong negative correlations at S-1 with BOD (r = - 0.980).

During the period 2014-2015, total solids have been found to be positively correlated with total hardness at S-1 (r = 0.821), with magnesium hardness S-1 (r = 0.919), In present study total solids have been found to be strong negatively correlated with dissolved oxygen at S-1 (r = - 0.839).

Hardness of water is mainly due to the presence of dissolved salts of calcium and magnesium. During 2014-2015, strong positive correlation of total hardness was observed with calcium hardness (r = 0.920), COD (r = 0.964), at S-1; with BOD (r = 0.956) at S-2,with chloride (r=0.965) and with nitrates (0.920) at S-3. Total hardness showed strong negative correlation with chloride S-2 (r = - 0.947). In the correlation study, it was found at most of the sampling stations that total hardness correlated with calcium hardness, magnesium hardness, chloride, sulphate. This indicates that hardness is mainly due to Cl^- and SO_4^{--} salts of calcium and magnesium. Similar results have been reported by many workers such as Singh, A.K.[13]; Jain, C.K. et al.[14] and Tyagi, P.[15]

During the study period 2014-2015 magnesium hardness showed strong positive correlation with chloride (r = 0.901) at S-1with COD (0.989) at S-3.During same study magnesium hardness was in strong negative correlation with calcium hardness (r = - 0.954); with DO (r = - 0.976) at S-1.

Dissolved oxygen (DO) is an important parameter to determine water quality because it is vital for aquatic life. USPHS has recommended that DO below the level of 4.0 mg/l is harmful to aquatic life. Positive correlations of DO with BOD and COD observed in the present study in certain samples may be due to increase in photosynthetic activity in the water body with increased biomass load on these waters, whereas negative correlation of DO with COD, nitrate, chloride sulphate and fluoride may be biochemical oxidation of these substances under aerobic conditions. Results similar to this study was reported by Zameel, A.[16] .During this period strong correlation of DO with fluoride (r = - 0.939) at S-2 and with nitrates (r = -0.958) at S-3.

Biochemical oxygen demand (BOD) is a standardized measurement of the amount of oxygen that would be required by micro-organisms to cause the decomposition of certain organic and inorganic matter in the water. In the assessment year 2014-2015, BOD was found to have positive correlation with COD (r = 0.868),with fluoride (r =

0.819), at S-3 and with fluoride (r=0.857) at S-2 .In the same period BOD showed strong negative correlation at S-1 with chloride (r = - 0.949).

During the study period 2014-2015, COD was strong positively correlated with phosphate (r = 0.893) at S-1; Strong negative correlation during this period was found with chloride (r = - 0.927) at S-1.Chlorides are readily soluble in water, therefore chloride ions are present in almost all waters. The presence of many chlorides in water could be the result of the washing out of the salts from the ground or by discharge of domestic sewage and industrial effluent into the water. Chlorides in excess (>250 mg/l) imparts a safety taste to water and people who are not accustomed to high chlorides can be subjected to laxative effects.[17] High chloride content has a deleterious effect on structures as well as on agricultural plants. The high content of chlorides is responsible for high hardness. Chloride though is not directly involved in corrosion, but it accelerates the rate of corrosion of steel and aluminum etc. During 2014-2015, chloride exhibited strong positive correlation with sulphate (r = 0.952) at S-2; with fluoride (r = 0.915) , with nitrates (r = 0.927) at S-3.

Correlation data recorded above indicate that nitrate, sulphate, fluoride, phosphate anions coexist in these water bodies along with chloride. Chloride contents found in our studies indicate that water from these hand pumps have very little concentration of chloride and which are well within the threshold limits.

Fluoride chemistry in aquatic system is quite complicated as the element fluorine will be mainly present as fluoride ion F^-. However depending upon the ionic concentration and pH of the solution, the fluorides are also present in the solution as HF_2 and undissociated HF. .Fluoride enters the aquatic system in the dissolved form through industrial discharge from aluminum industries, phosphate industries, coal plants etc.In the assessment year 2014-2015 fluoride exhibited strong positive correlation with phosphate (r = 0.980) at S-1; with phosphate (r = 0.900) at S-2 with nitrate (r = 0.825) at S-3 .

Sulphates generally have less effect on taste than chloride and carbonates. The high sulphates may induce diarrhea. Laxative effect may occur at lower concentration if magnesium is present in the water at an equivalent concentration. Cathartic effects are also found in people consuming drinking water containing sulphate concentration more than 600 mg/l. Sulphates are of considerable importance in the treatment of sewage and waste water. The correlation analysis does not show any pattern in the observed correlation coefficients of sulphate with phosphate and nitrate for all the sampling stations. Only at S-1, the sulphate showed positive correlation with phosphate(r= 0.902) .

One of the many factors to be taken into account in considering the possibility of reclaiming water for industrial or potable use is the phosphate content. During the natural process of weathering, the rocks gradually release the phosphorous as phosphate ions which are soluble in water and the mineralize phosphate compounds breakdown and increase the phosphate concentration Phosphate showed strong positive correlation with nitrate (r=0.901) in the majority of observations taken during the study period.

Conclusion

In the present study, the various anions show positive correlation with a particular parameter at one place, the same ion shows negative correlation with the sample parameter the other sampling site or at the same site in some other assessment year. This unpredictable behavior found during correlation analysis needs to be addressed. The overall behavior of the ions in these water samples can be known when pollution due to cations and biological parameters is studied and their behavior is correlated with the behavior of studied anions. Thus, these water samples are still open for future investigation. A continuous assessment of the quality of these waters is sincerely suggested.

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Table 1; Physico-Chemical characteristics of water samples collected from sampling station S-1 (Pandari Pani) during year 2014-2015

S.No	Parameters	Units	Months			
			Oct-14	Jan-15	Apr-15	Jul-15
1	Temperature	°C	32.10	23.60	36.60	34.00
2	pH	-	7.20	7.42	7.32	7.20
3	Electrical conductivity	µmho/cm	258.80	260.60	357.60	390.10
4	Oxidation-reduction potential	mV	340.80	352.20	355.10	416.80
5	Total Dissolved solids	mg/l	191.00	188.00	195.00	206.00
6	Total Suspended solids	mg/l	35.00	42.00	25.00	39.00
7	Total Solids	mg/l	226.00	230.00	220.00	245.00
8	Total Hardness	mg/l	273.00	280.00	275.00	266.00
9	Magnesium Hardness	mg/l	123.00	114.00	130.00	130.00
10	Calcium Hardness	mg/l	150.00	166.00	145.00	136.00
11	Dissolved oxygen	mg/l	6.90	7.20	6.70	6.80
12	Biological Oxygen Demand	mg/l	0.80	0.60	1.40	0.60
13	Chemical Oxygen Demand	mg/l	138.00	146.00	144.00	126.00
14	Chloride	mg/l	20.24	18.82	20.91	22.52
15	Fluoride	mg/l	0.74	0.81	0.88	0.72
16	Sulphate	mg/l	18.00	7.60	10.00	14.00
17	Phosphate	mg/l	0.32	0.40	0.46	0.26
18	Nitrate	mg/l	4.20	5.46	4.43	5.31

Table No.2 : Physico-Chemical characteristics of water samples collected from sampling station S-2 (Indra Nagar) during year 2014-2015

S.No	Parameters	Units	Months			
			Oct-14	Jan-15	Apr-15	Jul-15
1	Temperature	°C	31.40	25.20	35.50	33.60
2	pH	-	6.92	6.35	6.49	7.21
3	Electrical conductivity	µmho/cm	368.70	342.40	348.90	337.30
4	Oxidation-reduction potential	mV	446.60	360.70	452.40	437.30
5	Total Dissolved solids	mg/l	188.00	191.00	188.00	206.00
6	Total Suspended solids	mg/l	44.00	35.00	52.00	39.00
7	Total Solids	mg/l	232.00	276.00	240.00	245.00
8	Total Hardness	mg/l	268.00	276.00	280.00	272.00
9	Magnesium Hardness	mg/l	110.00	115.00	114.00	118.00
10	Calcium Hardness	mg/l	158.00	161.00	166.00	154.00
11	Dissolved oxygen	mg/l	7.60	7.90	6.60	7.00
12	Biological Oxygen Demand	mg/l	0.40	0.80	1.40	0.60
13	Chemical Oxygen Demand	mg/l	58.00	55.00	62.00	56.00
14	Chloride	mg/l	13.97	10.91	17.33	18.93
15	Fluoride	mg/l	0.60	0.64	1.12	0.84
16	Sulphate	mg/l	5.40	5.00	10.00	12.00
17	Phosphate	mg/l	0.22	0.28	0.42	0.40
18	Nitrate	mg/l	2.60	6.20	7.53	7.20

Table No.3; Physico-Chemical characteristics of water samples collected from sampling station S-3 (Anand Nagar) during year 2014-2015

S.No	Parameters	Units	Months			
			Oct-14	Jan-15	Apr-15	Jul-15
1	Temperature	°C	31.40	25.30	35.40	34.20
2	pH	-	6.80	7.02	7.80	7.00
3	Electrical conductivity	µmho/cm	630.60	666.90	526.60	560.20
4	Oxidation-reduction potential	mV	445.10	415.50	432.70	425.30
5	Total Dissolved solids	mg/l	237.00	250.00	242.00	216.00
6	Total Suspended solids	mg/l	88.00	90.00	110.00	80.00
7	Total Solids	mg/l	325.00	340.00	352.00	296.00
8	Total Hardness	mg/l	521.00	525.00	536.00	526.00
9	Magnesium Hardness	mg/l	189.00	205.00	200.00	192.00
10	Calcium Hardness	mg/l	332.00	320.00	336.00	334.00
11	Dissolved oxygen	mg/l	7.90	8.20	6.90	7.20
12	Biological Oxygen Demand	mg/l	0.80	1.20	1.40	0.60
13	Chemical Oxygen Demand	mg/l	66.00	78.00	76.00	68.00
14	Chloride	mg/l	128.60	136.80	149.80	140.60
15	Fluoride	mg/l	0.72	1.06	1.70	0.92
16	Sulphate	mg/l	2.30	3.20	3.80	5.00
17	Phosphate	mg/l	0.67	0.58	0.82	0.54
18	Nitrate	mg/l	6.00	6.20	17.72	12.36

Table No.4: Correlation Matrix for various Physico-Chemical parameters of water during 2014-2015
Sampling Station S-1 (Pandari Pani)

	Temp.	pH	EC	ORP	TDS	TSS	TS	TH	Mg-H	Ca-H	DO	BOD	COD	Cl^-	F^-	SO_4^{2-}	PO_4^{3-}	NO_3^-
Temp.	1.000																	
pH	-0.642	1.000																
EC	0.705	-0.348	1.000															
ORP	0.286	-0.404	0.798	1.000														
TDS	0.605	-0.613	0.902	0.934	1.000													
TSS	-0.770	0.108	-0.340	0.283	-0.029	1.000												
TS	-0.089	-0.378	0.430	0.887	0.719	0.674	1.000											
TH	-0.641	0.870	-0.705	-0.795	-0.919	0.004	-0.676	1.000										
Mg-H	0.967	-0.647	0.852	0.516	0.781	-0.630	0.139	-0.761	1.000									
Ca-H	-0.879	0.791	-0.839	-0.678	-0.895	0.382	-0.396	0.920	-0.954	1.000								
DO	-0.998	0.610	-0.742	-0.317	-0.627	0.770	0.072	0.638	-0.976	0.883	1.000							
BOD	0.645	0.091	0.276	-0.359	-0.089	-0.980	-0.748	0.167	0.505	-0.227	-0.652	1.000						
COD	-0.413	0.805	-0.597	-0.849	-0.884	-0.262	-0.836	0.964	-0.569	0.788	0.411	0.421	1.000					
Cl^-	0.780	-0.739	0.885	0.809	0.965	-0.231	0.552	-0.947	0.901	-0.981	-0.792	0.088	-0.855	1.000				
F^-	0.079	0.692	0.022	-0.475	-0.413	-0.642	-0.751	0.644	-0.017	0.307	-0.106	0.781	0.787	-0.370	1.000			
SO_4^{2-}	0.428	-0.922	-0.039	0.069	0.267	-0.031	0.175	-0.623	0.361	-0.505	-0.378	-0.154	-0.583	0.420	-0.706	1.000		
PO_4^{3-}	-0.054	0.742	-0.179	-0.632	-0.587	-0.573	-0.832	0.771	-0.180	0.464	0.035	0.721	0.893	-0.537	0.980	-0.676	1.000	
NO_3^-	-0.585	0.419	0.158	0.556	0.229	0.739	0.682	0.019	-0.365	0.229	0.543	-0.653	-0.186	-0.034	-0.185	-0.560	-0.227	1.000

Table No.5: Correlation Matrix for various Physico-Chemical parameters of water during 2014-2015
Sampling Station S-2 (Indra Nagar)

	Temp.	pH	EC	ORP	TDS	TSS	TS	TH	Mg-H	Ca-H	DO	BOD	COD	Cl^-	F^-	SO_4^{2-}	PO_4^{3-}	NO_3^-
Temp.	1.000																	
pH	0.458	1.000																
EC	0.080	0.039	1.000															
ORP	0.936	0.550	0.398	1.000														
TDS	0.177	0.709	-0.667	0.040	1.000													
TSS	0.790	-0.095	0.394	0.778	-0.451	1.000												
TS	-0.824	-0.579	-0.584	-0.971	0.050	-0.708	1.000											
TH	0.113	-0.703	-0.509	-0.178	-0.225	0.352	0.369	1.000										
Mg-H	0.058	0.196	-0.972	-0.237	0.817	-0.379	0.418	0.352	1.000									
Ca-H	0.077	-0.846	0.115	-0.027	-0.763	0.607	0.104	0.791	-0.294	1.000								
DO	-0.922	-0.210	0.230	-0.732	-0.203	-0.750	0.548	-0.463	-0.306	-0.273	1.000							
BOD	0.348	-0.617	-0.314	0.096	-0.322	0.611	0.088	0.956	0.187	0.854	-0.633	1.000						
COD	0.737	-0.209	0.337	0.697	-0.497	0.992	-0.614	0.459	-0.350	0.697	-0.741	0.698	1.000					
Cl^-	0.907	0.631	-0.270	0.770	0.568	0.477	-0.623	0.074	0.436	-0.209	-0.883	0.221	0.422	1.000				
F^-	0.749	-0.124	-0.345	0.499	0.039	0.727	-0.288	0.738	0.339	0.532	-0.939	0.857	0.761	0.691	1.000			
SO_4^{2-}	0.768	0.509	-0.551	0.544	0.683	0.311	-0.354	0.254	0.681	-0.185	-0.853	0.322	0.284	0.952	0.731	1.000		
PO_4^{3-}	0.647	0.089	-0.673	0.338	0.448	0.389	-0.103	0.646	0.705	0.199	-0.873	0.676	0.415	0.780	0.900	0.902	1.000	
NO_3^-	0.253	-0.189	-0.882	-0.103	0.422	0.075	0.339	0.788	0.835	0.258	-0.590	0.696	0.143	0.458	0.735	0.690	0.901	1.000

Table No.6; Correlation Matrix for various Physico-Chemical parameters of water during 2014-2015
Sampling Station S-3 (Anand Nagar)

	Temp.	pH	EC	ORP	TDS	TSS	TS	TH	Mg-H	Ca-H	DO	BOD	COD	Cl^-	F^-	SO_4^{2-}	PO_4^{3-}	NO_3^-
Temp.	1.000																	
pH	0.498	1.000																
EC	-0.935	-0.720	1.000															
ORP	0.512	-0.056	-0.219	1.000														
TDS	-0.599	0.246	0.475	-0.142	1.000													
TSS	0.293	0.898	-0.449	0.154	0.569	1.000												
TS	-0.205	0.621	0.049	-0.004	0.901	0.869	1.000											
TH	0.527	0.990	-0.765	-0.137	0.144	0.828	0.523	1.000										
Mg-H	-0.509	0.461	0.186	-0.751	0.697	0.464	0.664	0.457	1.000									
Ca-H	0.986	0.409	-0.868	0.644	-0.583	0.262	-0.212	0.422	-0.614	1.000								
DO	-0.926	-0.723	1.000	-0.188	0.478	-0.442	0.054	-0.772	0.166	-0.854	1.000							
BOD	-0.150	0.753	-0.088	-0.217	0.817	0.888	0.959	0.687	0.798	-0.203	-0.091	1.000						
COD	-0.399	0.580	0.074	-0.671	0.709	0.586	0.735	0.568	0.989	-0.504	0.056	0.868	1.000					
Cl^-	0.514	0.919	-0.782	-0.314	-0.022	0.657	0.334	0.965	0.465	0.382	-0.795	0.552	0.553	1.000				
F^-	0.374	0.990	-0.628	-0.170	0.339	0.898	0.678	0.980	0.582	0.276	-0.634	0.819	0.690	0.915	1.000			
SO_4^{2-}	0.469	0.285	-0.631	-0.470	-0.682	-0.166	-0.498	0.415	0.030	0.338	-0.652	-0.242	0.030	0.629	0.263	1.000		
PO_4^{3-}	0.475	0.785	-0.508	0.494	0.417	0.934	0.744	0.699	0.126	0.491	-0.492	0.691	0.264	0.490	0.741	-0.279	1.000	
NO_3^-	0.795	0.882	-0.954	0.025	-0.240	0.626	0.186	0.920	0.114	0.700	-0.958	0.356	0.229	0.927	0.825	0.610	0.590	1.000