CHAPTER – IV

WATER QUALITY INDEX

Materials and methods:

Water samples collected from eight sampling stations selected for the analysis were given bellow: S_1–Durgi (Bore Well), S2 –Rayavaram (Bore Well), S3 -Adigoppula(Bore Well), S4 – Terla(Bore Well), S5 - Karempudi(Bore well & open well), S6 – Macherla(Bore Well& open well) S7 –Ganapavaram (Bore well) and S8-Chirumamilla(Bore Well). Samples for analysis were collected in sterilized bottles using the standard procedure for grab (or) catch samples in accordance with standard methods of APHA (1995). The analysis of various physico – chemical parameters namely pH, temperature, total hardness, alkalinity, calcium hardness, magnesium hardness, chloride, sulphate, nitrate, DO, BOD, COD, TDS etc., were carried out – as per the methods described in APHA (1992). All the chemicals and reagents used were of analytical grade. D.D water was used for the preparation of solutions.

Water Quality Index (WQI):

WQI indicates the quality of water in terms of index number which represents overall quality of water for any intended use. It is defined as a rating reflecting the composite influence of different water quality parameters were taken into consideration for the calculation of water Quality index (WQI) .The indices are among

the most effective ways to communicate the information on water quality trends to the general public or to the policy makers and in water quality management. In formulation of water quality index the relative importance of various parameters depends on intended use of water. Mostly it is done from the point of view of its suitability for human consumption.

The calculation of WQI was made using weighed Arithmetic index method (Brown et al,1972) in the following steps:

Let there be n water quality parameters and quality rating (q_n) corresponding to nth parameter is a number reflecting relative value of this parameter in the polluted water with respect to its standard permissible value. q_n values are given by the relationship.

$q_n=100 \; (v_n-v_i) \; / \; (v_s-v_i)$

v_s = Standard value, v_n = observed value v_i = ideal value

In most cases $v_i=0$ except in certain parameters like pH, dissolved oxygen etc.,

Calculation of quality rating for pH & DO $(v_i \neq 0)$

$q_{pH} = 100 \; (v_{pH} – 7.0) \; / \; (8.5 – 1.0)$ and

$q_{DO} = 100 \; (V_{DO} – 14.6) \; / \; (15.0\text{-}14.6)$.

Calculation of unit weight :   The Unit weight (W_n) to various water Quality parameters are inversely proportional to the recommended   standards for the corresponding parameters.

$$Wn = k/s_n.$$

Where w_n = unit weight for nth parameter

s_n = standard permissible value for nth parameter

k = proportionality constant.

The unit weight (w_n) values in the present study are taken from Krishnan et al., 1995

WQI is calculated by the following equation.

$$WQI \ = \ \sum_{n=1}^{n} q_n \ w_n \ / \sum_{n=1}^{n} \ w_n \ .$$

The suitability of WQI values for human consumption according to Mishra & Patel, 2001 are rated as follows.

0-25   .... .Excellent

26-50 .... Good

51-75 ....Bad

76-100 .... Very Bad

100 & above ....Unfit.

Assessment of water quality based on WQI :

Application of WQI is a useful method in assessing   the suitability of water for various beneficial uses.

Results and discussion:

The physico – chemical parameters of the water samples are presented in Table – 1

Temperature :

Temperature of water is basically important because it effects bio-chemical reactions in aquatic organisms. A rise in temperature of water leads to the speeding up of chemical reactions in water, reduces the solubility of gases and amplifies the tastes and odours. The average temperature of the present study ranged from 26.93.....28.21^0 c. The pH value of natural water changes due to the biological activity and industrial contamination. Higher pH includes the formation of trihalomethanes which are toxic (Trivedi 1986). The pH values of the present investigation were within the ICMR standards (7.0 – 8.5) .

Electrical conductivity

Conductivity is a measure of current carrying capacity. Thus, as concentration of dissolved salts increases conductivity also increases. Many dissolved substances may produce aesthetically displeasing colour, taste and odour. The values obtained are in the range 0.9 to 1.8 mmhos.

Total Dissolve Solids:

TDS values ranged within 420 to 709mg/lt. The TDS values for ground water range from 19 to 1280mg/lt as per standards and in this respect this water is suitable for drinking purposes.

Dissolved Oxygen(DO):

It is an important parameter which is essential to the metabolism of all aquatic organisms that posses aerobic respiration (Wetzel, 1975) presence of DO in water may be due to direct diffusion from air and photosynthetic activity of autotrophs (Shanti etal., 2002). Oxygen can be rapidly removed from the waters by discharge of oxygen demanding wastes. The DO values obtained in the present study are within ICMR standards.

Alkalinity :

Alkalinity value with less than 100mg/lt is desirable for domestic use. However, in large quantities imparts bitter taste to water. In the present investigation the total alkalinity of the water samples is found in the Range 106.4 to 162.2 mg/lt.

Hardness :

Hardness is a measure of the ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatty acids from soap solutions. The principal hardness causing cations are calcium, magnesium bicarbonate, carbonate, chloride

and sulphates. The hardness values of the present study were found to range between 220.4 to 532 mg/lit.

The quantities of calcium in natural water depend up on the type of rocks. Small concentration of calcium is beneficial in reducing the corrosion in water pipes. Magnesium hardness particularly associated with sulphate ion has laxative effect an persons un accustomed to it (Khursid,1998). In the present study calcium and magnesium contents are found in the range of 85.4 – 169.5 and 26.8- 78.2 mg/lt   respectively.

Chloride:

Chloride occurs in all types of natural waters. The high concentration of chloride is considered to be an indication of pollution due to high organic waste of animal origin (Singh, 1995). Chloride values obtained in the study are found in the range between 74.2-134.0 mg / lt. Bio-Chemical Oxygen Demand (BOD) & Chemical Oxygen Demand (COD) BOD & COD are the parameters used to assess the pollution of surface water and ground waters. Both of the parameters (BOD & COD) values obtained in the present study are within permissible levels.

Sulphate:

Sulphate ion does not affect the taste of water, if present in low concentrations. The sulphate ion concentration in the present investigation varied from 87.5-185.0 mg/lt.

Nitrate:

Nitrate is the most important nutrients in an ecosystem. Generally water bodies polluted by organic matter exhibit higher values of nitrate. In the present study water samples from the stations (s_1 to s_8) showed low concentrations of nitrate (1.34 to 2.15 mg/lt) well below permissible levels as per the standards.

The WQI values of the present investigation (Table - 3) from different sampling stations are calculated as per the procedure described earlier. The water quality index values are given in Table – 7. Basing on the results obtained, it can be said that, some of the samples have total dissolved solids, hardness and calcium values exceeding the permissible limits as prescribed by Indian standards. However the WQI values (38.3 – 42.6) calculated for the different samples indicate that the water is safe for human consumption. It can safely be considered that the values of WQI in the present investigation were reported to be less than 50, indicating that the water is suitable for human consumption.

Table – 1

Physico – Chemical Parameters of Water Samples Collected on 12-12-2009

Parameter	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Temperature ^0C	27.12	28.0	28.17	27.65	27.18	28.02	27.56	27.03
pH	7.30	7.65	7.24	7.38	7.09	7.81	7.35	7.76
Electrical Conductivity	1.4	1.8	0.9	1.6	1.2	1.0	1.3	1.7
TDS	469	710	432	502	633	415	528	571
TSS	42.3	58.3	61.2	48.9	62.1	33.2	53.8	42.5
Hardness	528	292	254	305	210.5	376	415	368
Calcium	109	99.2	82.3	172.5	90.8	122.3	170.6	113.5
Magnesium	63.8	52.4	29.8	73.9	29.9	54.9	60.8	74.8
Chloride	54.9	80.2	109.8	114.8	97.2	125.8	122.3	152.9
DO	4.6	4.3	5.2	4.2	4.3	4.0	4.3	4.6
BOD	1.2	0.8	1.0	0.8	0.9	0.8	1.2	1.2
Sulphate	128.9	92.5	115.9	170.2	82.5	99.5	164.8	162.8
Alkalinity	112.8	148.3	103.8	128.3	148.9	103.8	140.3	110.8
Nitrate	1.30	1.93	2.01	1.62	1.31	1.52	1.63	2.11
COD	5.0	4.2	5.0	5.3	5.9	4.3	6.0	5.3
Iron	0.002	0.002	0.004	0.002	0.003	0.003	0.003	0.002

All the parameters expressed in mg/lit. except pH and EC (mmhos)

* All the values are the average of 3 determinations.

Table – 2

Physico – Chemical Parameters of Water Samples Collected on 11-01-2010

Parameter	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Temperature ^{0}C	27.32	27.52	28.0	27.52	27.78	28.02	27.91	27.53
pH	7.50	7.3	7.62	7.75	7.82	7.8	7.45	7.78
Electrical Conductivity	1.3.	1.7	1.0	1.8	1.3	1.0	1.5	1.5
TDS	541	606	420	552	608.2	468	493	552
TSS	79.2	78.5	57.9	66.6	68.0	33.9	82.3	62.8
Hardness	423	308.5	215.0	305.5	252.4	382.6	428.2	322.0
Calcium	107.8	86.0	94.3	109.0	115.3	139.2	155.5	122.6
Magnesium	58.6	46.6	44.2	72.5	56.7	58.5	72.9	64.2
Chloride	79.2	77.5	112.6	86.3	124.0	115.7	144.0	160.5
DO	4.0	4.0	5.0	4.0	4.5	4.2	4.4	4.3
BOD	1.2	0.5	1.2	0.8	0.7	0.8	1.4	1.2
Sulphate	112.0	115.2	84.2	162.5	92.5	108.5	165.8	150.5
Alkalinity	164.0	134.5	96.3	152.0	172.0	122.4	140.8	95.6
Nitrate	1.22	1.18	1.2	1.80	1.34	1.65	1.98	2.05
COD	5.2	4.8	5.0	5.0	5.0	4.9	6.2	5.5
Iron	0.0023	0.002	0.003	0.003	0.004	0.002	0.004	nd

All the parameters expressed in mg/lit. Except pH and EC (mmhos)

* All the values are the average of 3 determinations.

Table – 3

Physico – Chemical Parameters of Water Samples Collected on 11-02-2010

Parameter	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Temperature ^0C	27.08	28.10	28.21	27.82	27.08	28.11	27.49	26.93
pH	7.30	7.60	7.42	7.42	7.79	7.8	7.55	7.72
Electrical Conductivity	1.5.	1.9	0.9	1.8	1.2	1.0	1.5	1.3
TDS	562	709	420	532	628.	468	525	576
TSS	49.7	58.5	63.9	46.1	58.0	33.9	52.3	42.8
Hardness	532	314.5	220.4	345.1	232.4	382.6	420.2	352.6
Calcium	127.0	106.2	85.4	169.5	91.3	139.2	175.2	112.6
Magnesium	78.2	56.0	27.2	72.5	26.8	58.5	62.4	74.8
Chloride	74.2	87.5	123.2	116.3	94.0	115.7	134.0	163.5
DO	4.8	4.5	5.0	4.0	4.7	4.2	4.6	4.3
BOD	1.3	0.5	1.2	0.8	0.7	0.8	1.4	1.2
Sulphate	132.0	96.5	125.2	185.0	87.5	108.5	175.2	162.0
Alkalinity	128.5	156.0	106.4	132.0	162.2	122.4	150..6	115.1
Nitrate	1.38	1.92	2.13	1.80	1.34	1.65	1.85	2.15
COD	5.2	4.8	5.2	5.3	6.0	4.9	6.2	5.8
Iron	0.002	0.003	0.004	0.002	0.003	0.003	0.004	nd

All the parameters expressed in mg/lit. except pH and EC (mmhos)

* All the values are the average of 3 determinations.

Table – 4

Physico – Chemical Parameters of Water Samples Collected on 11-03-2010

Parameter	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Temperature ^0C	27.08	28.10	28.21	27.82	27.08	28.11	27.49	26.93
pH	7.30	7.60	7.42	7.42	7.79	7.8	7.55	7.72
Electrical Conductivity	1.3	1.2	1.0	1.9	1.1	1.2	1.6	1.4
TDS	480	662	408	464	609	412	503	570
TSS	42.3	67.3	60.2	48.4	54.2	30.6	52.0	41.6
Hardness	508	286	205	316.3	212	360.3	403.8	330.3
Calcium	103.8	95.3	81.8	143.2	86.5	117.5	153.8	98.4
Magnesium	72.8	52.3	21.8	70.3	26.8	54.3	59.8	70.6
Chloride	78.4	80.3	104.8	105.8	89.3	108.3	124.5	148.3
DO	4.6	4.8	4.9	4.30	4.6	4.2	4.6	4.3
BOD	1.2	0.8	1.3	0.5	0.7	0.9	1.3	1.1
Sulphate	128.3	87.5	103.8	162.3	80.3	104.9	157.8	160.3
Alkalinity	118.5	126.2	98.5	114.5	145.8	102.5	132.8	95.3
Nitrate	1.24	1.68	2.08	1.81	1.34	1.53	1.78	2.06
COD	5.0	4.8	5.0	5.1	5.0	4.9	6.0	5.6
Iron	0.003	0.004	0.003	0.003	0.002	0.003	nd	nd

All the parameters expressed in mg/lit. except pH and EC (mmhos)

* All the values are the average of 3 determinations.

Table – 5

Physico – Chemical Parameters of Water Samples Collected on 11-04-2010

Parameter	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Temperature ^{0}C	27.10	28.23	27.90	27.12	28.15	27.39	26.99	27.28
pH	7.26	7.54	7.45	7.70	7.59	7.80	7.52	7.69
Electrical Conductivity	1.4	1.8	1.0	1.2	1.8	1.2	1.5	1.4
TDS	548	710	418	508	621	456	508	548
TSS	42.8	53.2	60.8	42.3	50.8	33.8	50.3	42.9
Hardness	512	308.3	211.5	328.3	230.8	376.3	408.2	342.8
Calcium	109.8	98.3	80.8	149.3	87.9	128.3	162.8	108.3
Magnesium	76.8	51.5	24.8	73.2	26.2	54.3	60.5	71.3
Chloride	72.8	80.3	108.3	106.8	93.2	108.3	123.2	160.1
DO	4.8	4.6	4.8	4.2	4.8	4.7	4.5	4.3
BOD	1.2	0.9	1.0	0.8	0.7	1.2	1.3	1.2
Sulphate	128.5	86.4	108.3	162.3	80.5	108.2	148.5	162.0
Alkalinity	103.5	140.5	98.3	108.5	142.8	103.5	135.5	105.3
Nitrate	1.28	1.62	2.08	1.05	1.14	1.54	1.36	2.05
COD	4.8	5.1	5.2	5.3	5.6	4.8	6.0	5.2
Iron	0.003	0.002	0.003	0.002	0.003	0.004	nd	nd

All the parameters expressed in mg/lit. Except pH and EC (mmhos)

* All the values are the average of 3 determinations.

Table – 6

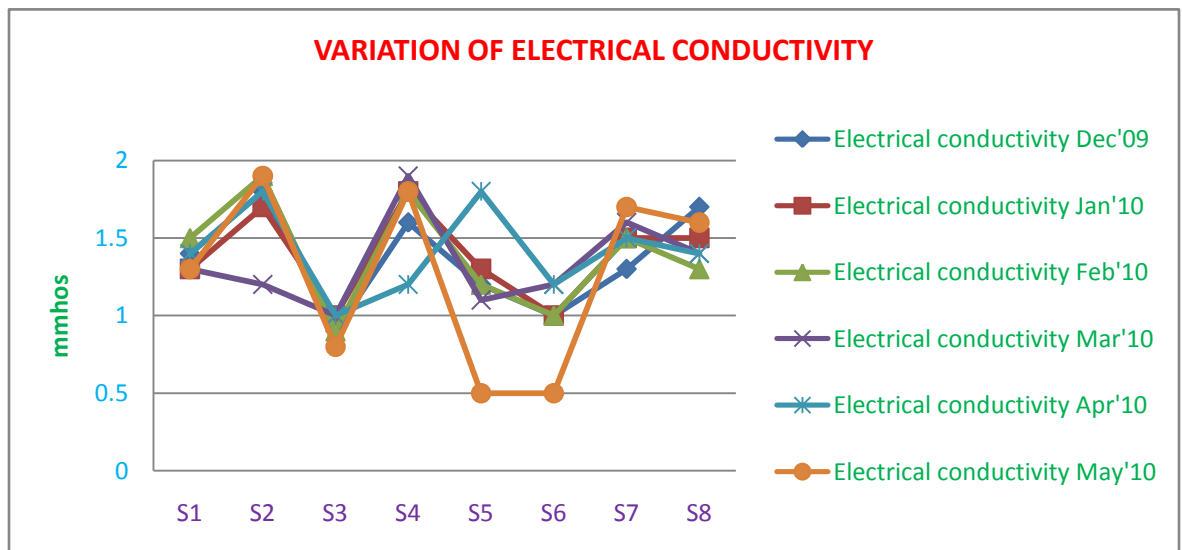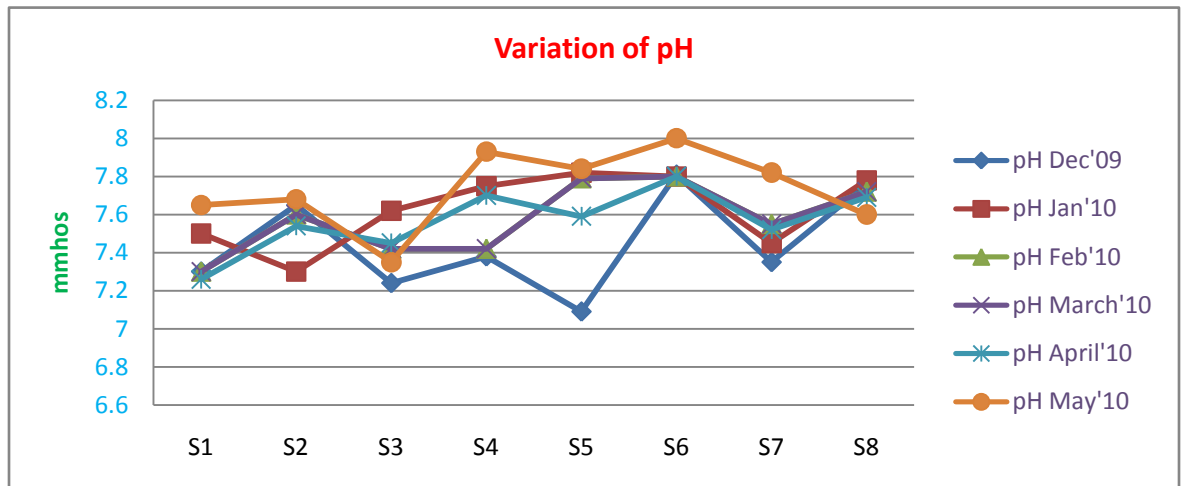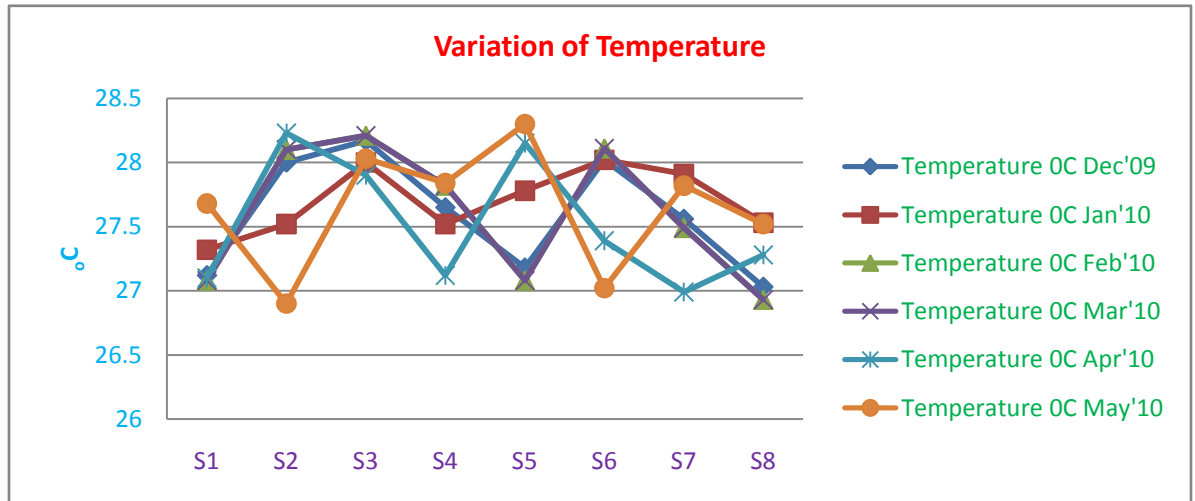**Physico – Chemical Parameters of Water Samples Collected on 11-05-2010**

Parameter	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
Temperature ^0C	27.68	26.90	28.03	27.84	28.3	27.02	27.82	27.52
pH	7.65	7.68	7.35	7.93	7.84	8.0	7.82	7.60
Electrical Conductivity	1.3	1.9	0.8	1.8	0.5	0.5	1.7	1.6
TDS	508	639	305	468	632	385	520	572
TSS	57.9	42.0	48.6	39.6	36.9	22.7	34.8	57.2
Hardness	490.3	304.8	212.0	340.6	239.5	299.2	418.6	389.4
Calcium	147.2	126.1	85.4	159.3	89.04	129.2	178.9	94.2
Magnesium	68.5	56.0	29.9	65.8	23.2	46.8	66.6	32.4
Chloride	89.2	68.7	103.7	126.3	92.3	115.8	132.7	97.8
DO	5.0	4.8	4.9	5.0	4.6	5.7	4.6	4.3
BOD	1.4	0.8	1.2	0.9	0.8	0.7	0.9	1.0
Sulphate	100.8	82.8	112.2	135.2	74.8	142.8	146.3	139.0
Alkalinity	118.0	149.3	108.2	122.5	162.0	110.5	140.4	115.8
Nitrate	1.42	1.03	1.80	2.13	1.22	1.65	1.25	2.01
COD	5.0	4.8	3.8	5.3	5.0	4.9	5.3	5.2
Iron	0.003	0.002	0.004	0.004	0.002	0.003	0.004	0.005

All the parameters expressed in mg/lit. except pH and EC (mmhos)
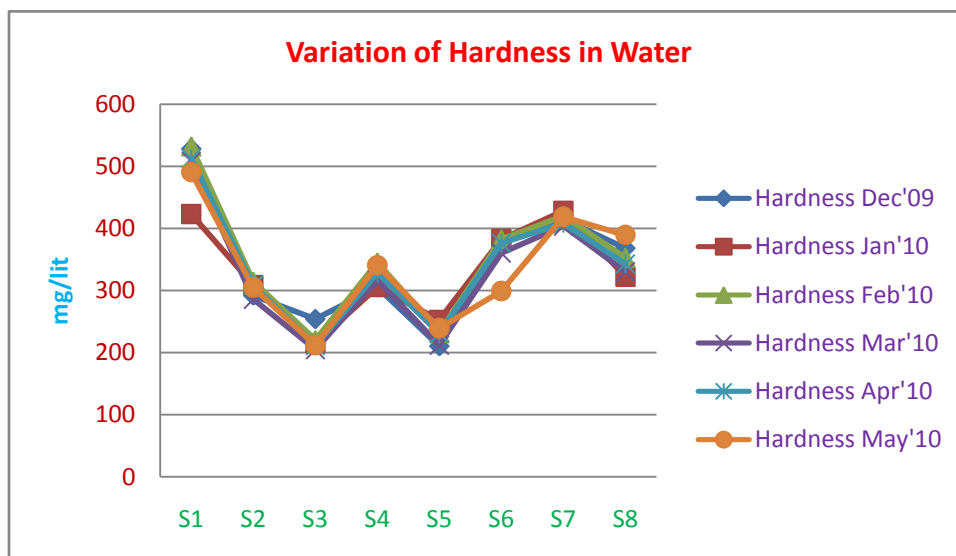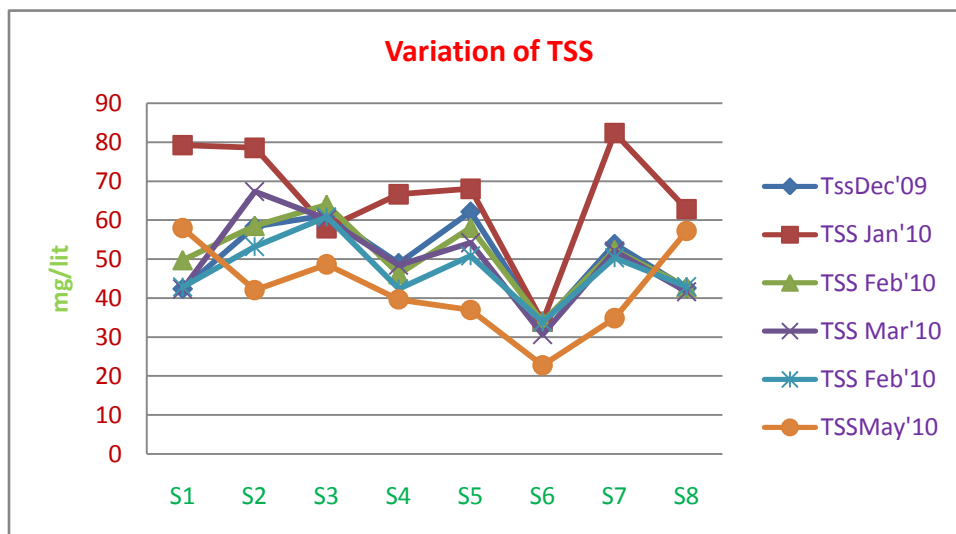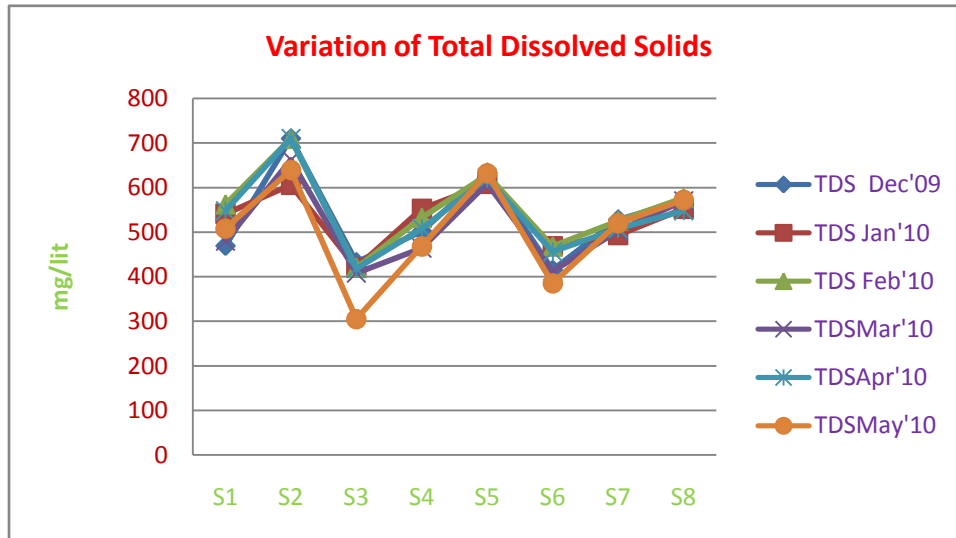
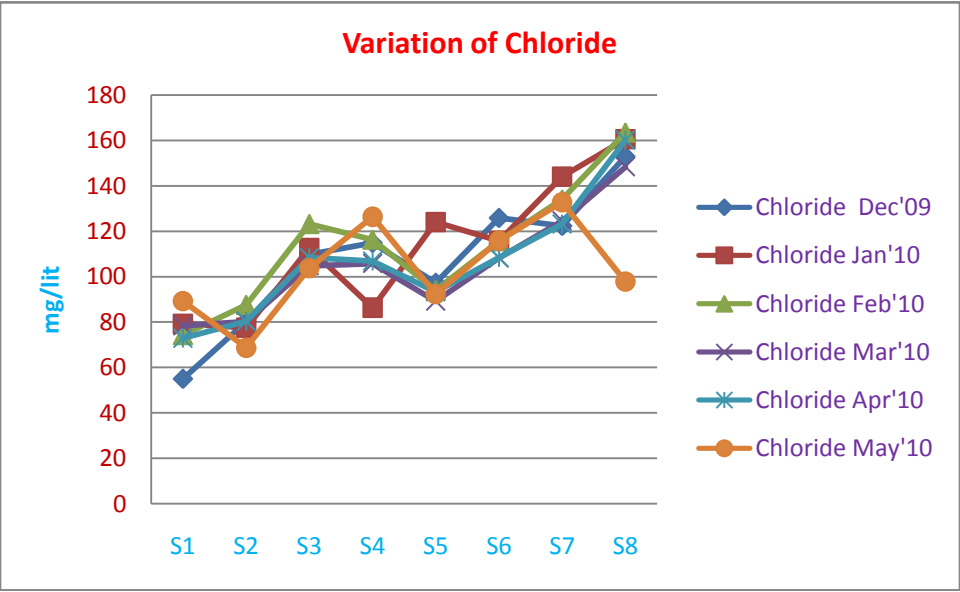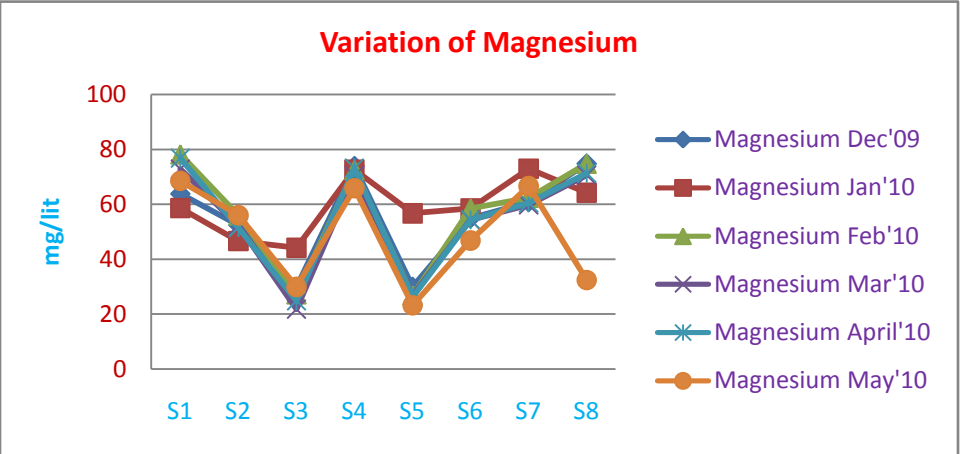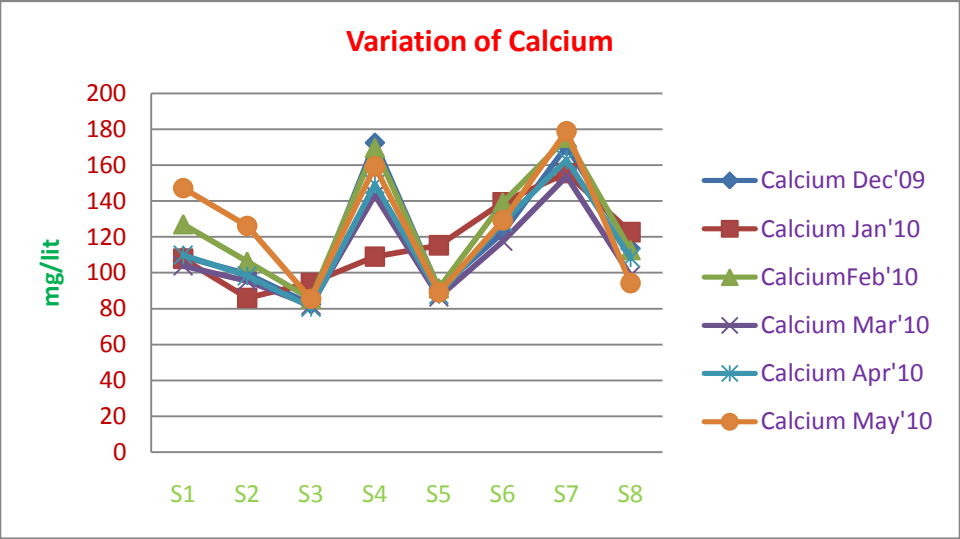* All the values are the average of 3 determinations. 'nd' values are taken in to '0' for Graphs

Table – 7

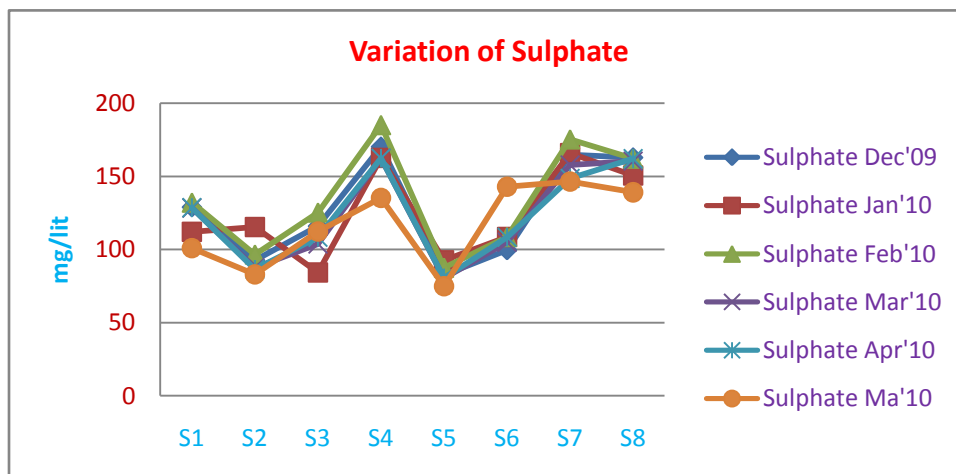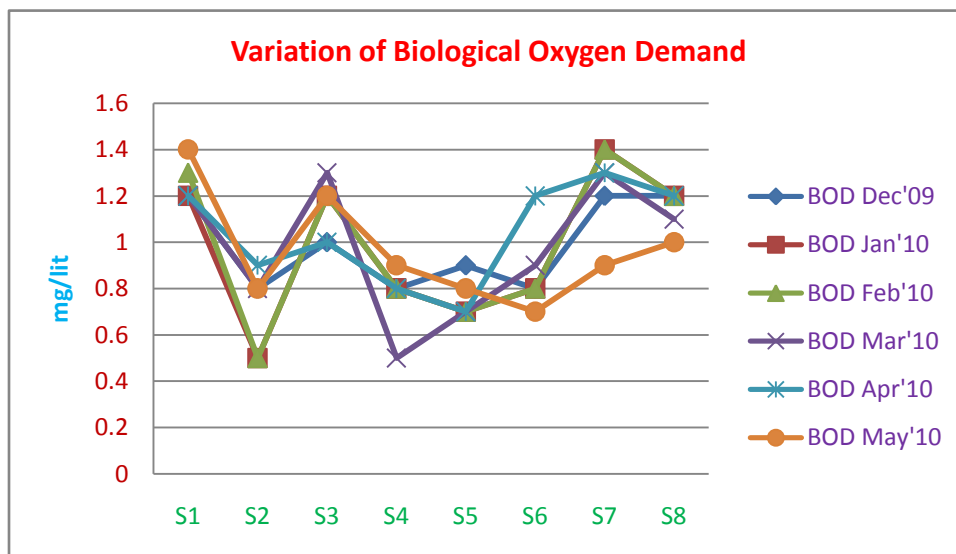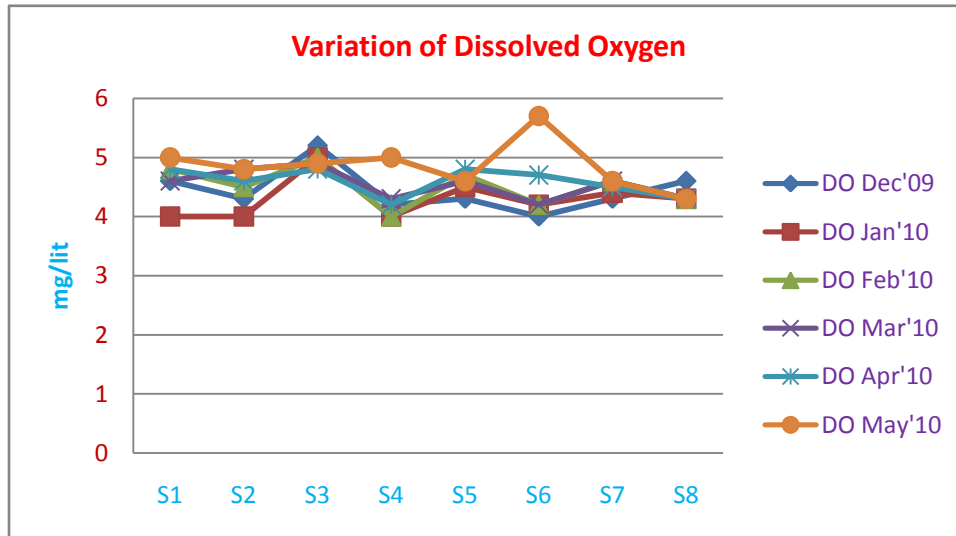## Water Quality Index of Well & Bore Well Waters of Guntur rural Date 11-02-2010

parameter	ICMR Standard	Unit weight(w_n)	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S8
pH	7.74	0.07164	6.7567	7.034	6.8678	7.21016	7.2195	7.2195	6.988	7.1455
TDS	500	0.00100	0.1124	0.1418	0.084	0.1256	0.0936	0.097	0.105	0.1152
TH	200	0.00167	0.4442	0.2626	0.1840	0.2881	0.1941	0.3195	0.35087	0.2944
DO	5	0.10030	9.629	9.027	10.03	8.024	9.428	.8.425	9.227	8.626
BOD	5	0.10030	2.608	1.003	2.4072	1.6048	1.4042	1.6048	2.8084	2.4072
Chloride	250	0.00200	0.05936	0.07	0.0986	0.09304	0.0752	0.09256	0.1072	0.1308
Total Alkalinity	120	0.00417	0.0447	0.05421	0.037	0.04587	0.05636	0.04253	0.05234	0.03997
NO_3	45	0.01111	0.03471	0.0474	0.052587	0.0555	0.04438	0.04074	0.04567	0.053081
COD	20	0.02507	0.65182	0.60163	0.65182	0.664	0.7521	0.6142	0.7772	0.72703
Sulphate	200	0.007418	0.04896	0.03579	0.04637	0.06862	0.03245	0.040242	0.064982	0.060086
Iron	0.3	1.6666	1.11066	1.666	2.22132	1.11066	1.666	1.666	2.22132	nd
w_n	----	----	1.98487	----	----	----	----	----	----	----
q_n	----	----	21.50051	19.94345	22.6807	19.29035	20.96589	20.1621	22.7479	19.5993
WQI	----	----	42.6757	39.587	45..01824	38.2889	41.6146	40.0191	45.1518	38.9020

Variation of Temperature

Variation of pH

VARIATION OF ELECTRICAL CONDUCTIVITY

Variation of Total Dissolved Solids

Variation of TSS

Variation of Hardness in Water

Variation of Calcium

Variation of Magnesium
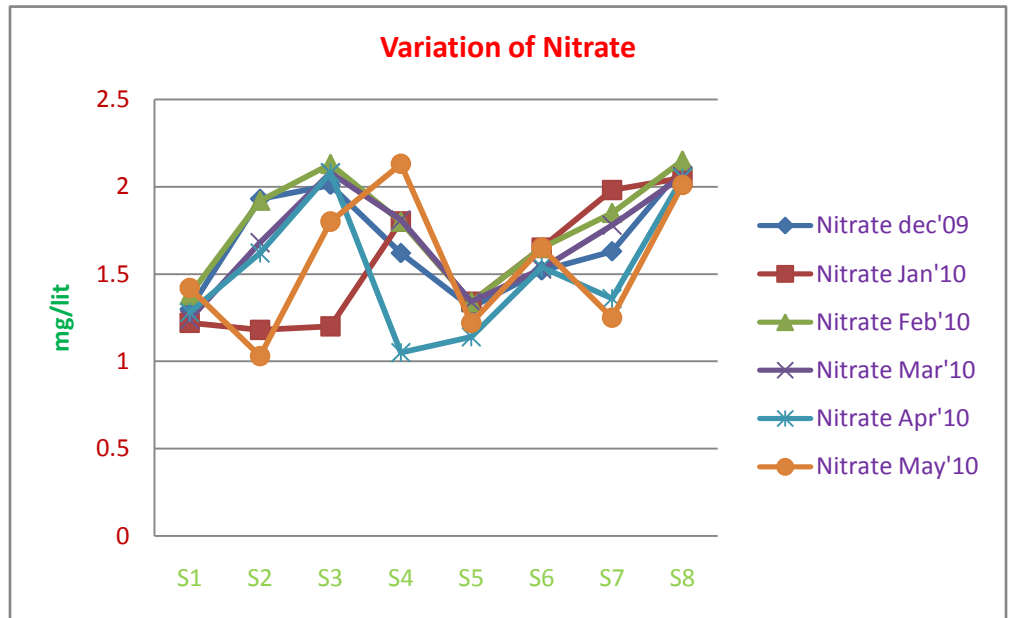

Variation of Chloride

Variation of Dissolved Oxygen

Variation of Biological Oxygen Demand

Variation of Sulphate
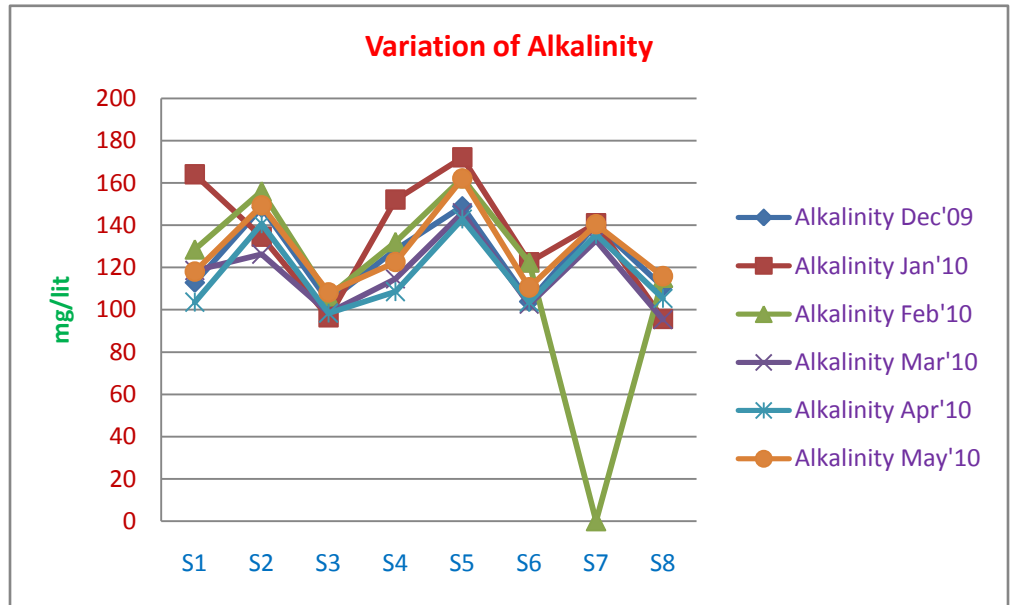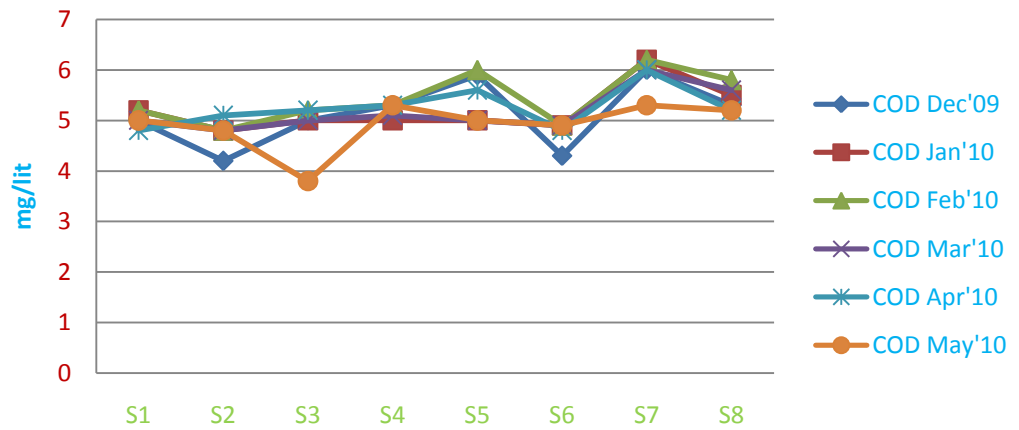
84

Variation of Alkalinity

Variation of Nitrate

Variation of Chemical Oxygen Demand

Variation of Iron