



**Short Communication**

**Quality and Assessment of Ground Water in Satna, Madhya Pradesh**

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**ABSTRACT**

*The usefulness of groundwater to a great extent depends on its chemistry. Ground water has been used a major source of drinking water in both rural and urban areas in the world. The present paper focuses the analysis of physico-chemical study of ground water quality of Satna. Fifteen water samples were collected from different locations of the city and analysis of water samples for different parameters like temperature, pH, TDS, DO, BOD, COD, nitrate and sulphate were carried out in the month of march-2014 by using standard methods. The estimated parameters were compared with standard water quality indices like WHO and BIS. Nitrate and sulphate of all the samples are within the WHO recommended values as 45 mg L<sup>-1</sup> and 250 mg L<sup>-1</sup>*

**Keywords:** Groundwater, physico-chemical parameters, Statistical analysis, Satna.

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**INTRODUCTION**

Groundwater is an invaluable commodity available in very limited quantities to human being and other living being. Water is basic need of the human being, and water sector is now a days a thrust area for econometrician and technical people. Water sector is already established industry in devolved country, but in developing country like India there is a heavy lode on the water utility to full fill requirement of the people effectively and effectively in a matter of quality and quantity. This is period of developing countries facing urbanisation and industrialisation which causes management of existing infrastructure [1, 2]. Water is one of the most essential requirements of life. The quality of ground water depends on a large number of hydrological, physical, chemical and biological factors. Generally higher proportions of dissolved constituent are found in ground water than in surface water because of grater interaction of groundwater with various materials in geological strata. Ground water has been used a major source of drinking water in both rural and urban areas in the world. In India, almost 80% of the rural population depends on untreated ground water [3]. The ground water used for drinking to be free from any toxic elements, living and non living organism; and excessive amount of minerals that may be hazardous to health. Assessment of groundwater quality requires determination of ion concentration which decides the suitability for drinking, agriculture and industrial uses [4-5].

The definition of water quality depends on the intended use of the water which may be consumptive and non consumptive, power generation, recreation etc. depending upon the purpose uses of water. Certain quality criteria are established and based on these criteria; quality standards are specified by health and other regulating agencies to ensure that the water quality in a resource is suitable for the purposed use. Different type of water use requires different levels of water purity. Drinking water requires the highest standards of purity where as water of relatively lower quality is acceptable for other purposes like agriculture, industries, fisheries, wild life, livestock, recreation (boating and swimming) and hydro electric. Various researchers in India have carried out extensive studies on ground water chemistry [6] of shallow aquifers in the costal zones of Cochin and concluded that groundwater present in the shallow aquifers at some of the station was poor in quality and was not suitable for potable use as per the standard stipulated by WHO and ISI. Rapid increase in urbanization and industrialization leads to deterioration in groundwater quality [7-11]. There are many sources that contribute contaminants to the ground water e.g. land disposal of solid wastes, disposal on land, agricultural activities, urban runoff and polluted surface water [12-16].

Satna is a town and district in the state of Madhya Pradesh India. The district of Satna is situated between latitude 23° 12' north and longitude 80° 21' and 81° 23' east in mid northern part of Rewa commissioner's in Madhya Pradesh State of India.

## MATERIALS AND METHODS

The sampling stations were chosen at different site of the study area, water samples were collected from industrial area, residential area of Satna. The present study is focused on water quality assessment for month of April 2014. For testing the Water samples were collected in different sterile plastic bottles and jerry cans from each station. After collection of the sample the bottles were tightly capped and were immediately transported to the laboratory to avoid any unpredictable changes in the physico-chemical characteristics. Fifteen sampling locations consisting of bore wells and hand pumps were selected in the study area. Sampling was done in accordance with grab sampling methods in polyethylene bottles of one liter capacity. To avoid leaching of metals and interaction with the surface wall of the container, bottles were first cleaned with detergent and then with 1:1 HNO<sub>3</sub> for 24 h. Finally bottles were cleaned and rinsed with the distilled water. During sampling bottles were rinsed two to three times with the sample to be examined before finally filling with it. Samples were collected by immersing the rinsed bottles in river water during sampling from hand pumps and bore wells, the water pumped to waste for about five minutes and sample was collected directly. All the samples were refrigerated at 4°C in the laboratory.[17] and procedures were followed as per the standard methods. The sampling locations are presented in table-1.

**Table: 1** List of sampling locations

SN	Sampling location	Water Source	Depth in ft	Description of sampling location
1	Dhawari (RW-1)	Tube well	240	Lane no. 5 Near Talab Satna.
2	Jawahar Nagar (RW-2)	Tube well	350	Behind Jawahar Nagar Stadium Satna.
3	Civil Line (RW-3)	Hand pump	250	Civil line Chowk Satna.
4	Gadhiya Tola (RW-4)	Hand pump	300	Near Gayatri Mandir Satna.
5	Bhattha (RW-5)	Hand pump	280	Near Pashupati Nath Temple Satna.
6	Sohawal (RW-6)	Hand pump	350	Near Peptic City Satna.
7	Pateri (RW-7)	Tube well	400	Behind Mahamtma Gandhi Collage Satna.
8	Khermai Rode (RW-8)	Hand pump	300	Inside Khermai Temple Satna.
9	Bus Stand (RW-9)	Hand pump	270	Near Hotal Basera Satna.
10	Eklavya Colony(RW-10)	Tube well	500	Infront of ITI collage satna.

11	Birla Cement Plant (IW-11)	Tube well	470	Inside Birla Cement Plant Satna.
12	Kaima (IW-12)	Hand pump	250	Near Betul Oil Mill Satna.
13	Sagma (IW-13)	Hand pump	450	Near Kamal Spanj Plant Satna.
14	UCL Bardadeeh (IW-14)	Tube well	400	Inside the UCL Bardadeeh Satna.
15	Jaypee Cement Plant Babupur Satna (IW-15)	Tube well	300	Inside the Jaypee Cement Plant Satna.

## RESULTS AND DISCUSSION

The ground water samples were analysed for some parameter like temperature, pH, TDS, TH, DO, BOD, COD, Nitrate and sulphate. Analysed all the result and the mean values of eleven parameters of ground water analysed in fifteen stations together with their SD and CV are presented in table-2, the correlation coefficient (r) among various water quality parameters are given in table-3. In the case of temperature, pH, TDS, TH, DO, BOD, COD, nitrate, and sulphate the mean value were recorded as 28.8, 7.66, 346.6, 467.3, 4.92, 5.03, 15.01, 14.52, 109.67 mg L<sup>-1</sup> respectively. The standard deviation value of temperature (3.14), pH (0.64), DO (0.60), BOD (0.83), COD (8.41), nitrate (7.91), sulphate (30.13) of each parameters between very little deviation, but in the case of TDS (154.63) and TH (102.97) S.D.value have greater deviation together all the each parameters. The coefficient variation values of temperature (10.9), pH (8.35), TDS (44.6), TH (22.03), DO (12.19), BOD (16.5), COD (56.02), nitrate (54.44) sulphate (27.5) showed wide fluctuations with each other with respect to relation of these parameters between stations. Present study deals with the various relationship derived statistically by calculation r among the physico-chemical characteristics. The r value was investigated negative eighteen times and positive twenty seven times showed positive relationship in the present ground water studied. Temperature showed positive relationship with pH, TDS, TH, DO, nitrate, and sulphate and negative relationship with BOD and COD. pH showed negative relationship with TDS, TH, DO, COD and nitrate and positive relationship with temperature, pH, BOD and sulphate.

TDS showed significant positive relationship between temperature, TH, DO, nitrate and sulphate and negative relationship with BOD and COD. TH in present investigation showed positive relationship between temperature, TDS, DO and nitrate and negative relationship with pH, BOD, COD and sulphate. Dissolved oxygen showed negative relationship with pH and BOD and positive relationship with temperature, TDS, TH, COD, nitrate and sulphate. Biochemical Oxygen Demand (BOD) showed negative relationship with temperature, TDS, TH, DO, COD, nitrate and sulphate and positive relationship with pH. Chemical Oxygen demand (COD) showed positive relationship with DO and negative relationship with temperature, pH, TDS, TH, BOD, nitrate and sulphate.

Nitrate showed positive with temperature, TDS, TH, DO and sulphate and negative relationship with pH, BOD and COD. Sulphate showed positive relationship with temperature, pH, TDS, DO, and nitrate and negative relationship with TH, BOD and COD.

**Table 2.** The physico-chemical characteristic of ground water at different points of Satna Region

Parameter	Sampling Location								
	RW1	RW2	RW3	RW4	RW5	RW6	RW7	RW8	RW9
Temperature	27	25	30	26	25	29	28	26	31
pH	7.1	8.13	7.19	7.24	7.2	8.4	8.5	7.2	7.3
TDS	550	160	250	270	200	210	230	300	180
TH	760	320	460	480	420	400	462	446	420
DO	5.68	5.44	4.5	4.26	4.2	4.6	4.3	3.9	4.8

<b>BOD</b>	4.5	4.35	5	5.9	5.81	5.05	5.86	7.02	4.26
<b>COD</b>	17.33	29	22.6	9.32	25.38	20	9.44	6.66	16
<b>Nitrate</b>	9.9	18.4	5.5	11.5	7.5	9	9.7	9.5	10.7
<b>Sulphate</b>	65	80	50	120	90	98	85	115	140

Table-2 continues.....

Parameter	Sampling Location								
	RW10	IW11	IW12	IW13	IW14	IW15	MEAN	S.D	C.V.
Temperature	29	26	32	35	29	34	28.80	3.14	10.9
<b>pH</b>	7.2	7.3	8.9	7.33	7.25	8.6	7.66	0.64	8.35
<b>TDS</b>	580	450	340	520	600	360	346.67	154.63	44.6
<b>TH</b>	522	470	350	570	510	420	467.33	102.97	22.03
<b>DO</b>	5.2	5.92	4.97	5.44	5.32	5.2	4.92	0.60	12.19
<b>BOD</b>	4.1	3.95	5.3	4.87	4.72	4.78	5.03	0.83	16.5
<b>COD</b>	28	8.55	1.33	12.66	9.9	9	15.01	8.41	56.02
<b>Nitrate</b>	21.9	21.3	6.1	30	27.8	19	14.52	7.91	54.44
<b>Sulphate</b>	125	120	145	128	148	136	109.67	30.13	27.5

All the parameters except temperature, and pH, are expressed in mg L<sup>-1</sup>

Table: 3. Correlation coefficients (r) among various water quality parameters (Physico-chemical characteristics of ground water in Satna Region)

Parameters	Temperature	pH	TDS	TH	DO	BOD	COD	Nitrate	Sulphate
Temperature	1								
<b>pH</b>	0.325294	1							
<b>TDS</b>	0.25858	-0.34194	1						
<b>TH</b>	0.031329	-0.54876	0.691713	1					
<b>DO</b>	0.223225	-0.0221	0.612847	0.340133	1				
<b>BOD</b>	-0.23205	0.058596	-0.36916	-0.16352	-0.84666	1			
<b>COD</b>	-0.29877	-0.28507	-0.16985	-0.00434	0.05536	-0.35886	1		
<b>Nitrate</b>	0.297818	-0.19556	0.656179	0.216917	0.638132	-0.4715	-0.00749	1	
<b>Sulphate</b>	0.438793	0.136982	0.323984	-0.20359	0.163261	-0.08982	-0.54044	0.47126	1

**Temperature:** Temperature of the samples was found between 25°C to 35 °C, the highest temperature was recorded 35°C at sampling station IW13 (Sagma). It is shown in fig.1

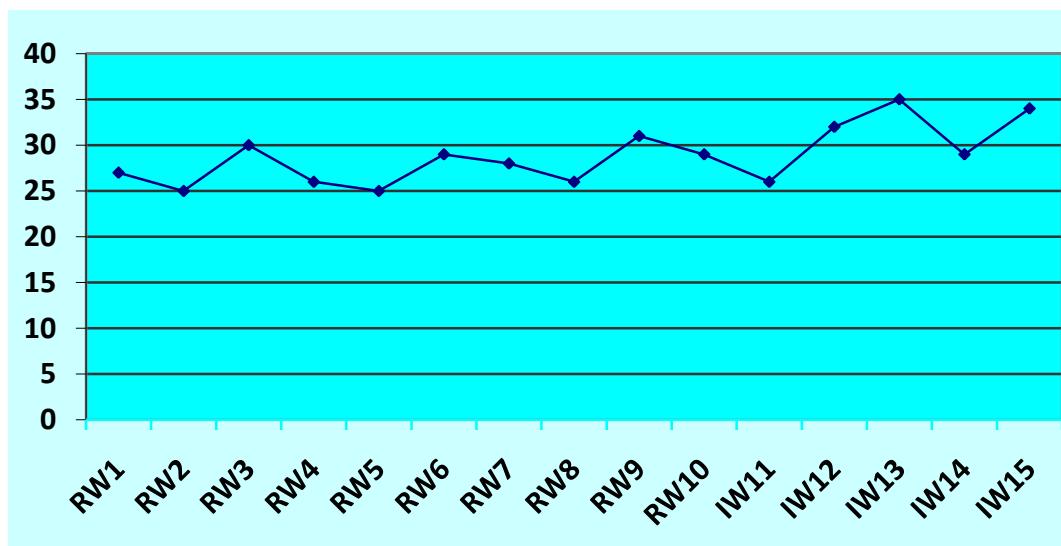


Fig 1

**pH:** The pH values of drinking water samples (Fig 2) are between 7.10 to 8.90. Low pH value associated with small amount of mineral acid from chloride source or with organic acid. High pH value associated with small amount of mineral acid from carbonate source or with inorganic acid. Its highest value found 8.90 and lowest value found 7.10. pH value of at sampling stations RW7 pateri (8.59), IW15 Jaypee cement plant Babupur 8.60 and IW12 Kaima (8.90) are more than the permissible limit prescribed WHO.

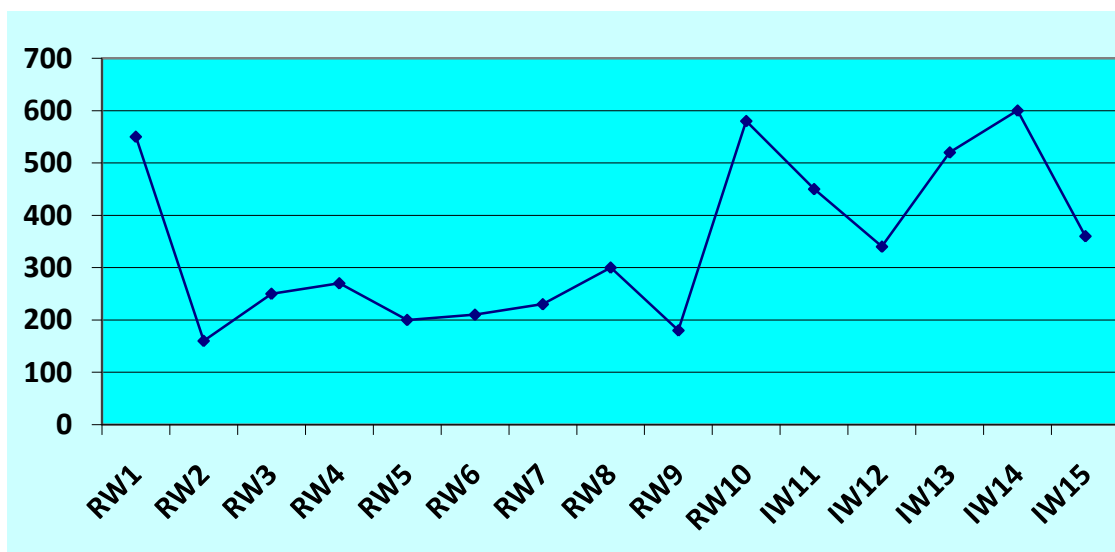


Fig 2

**Total Dissolve Solids:** Total dissolve solid content of a sample of water is important in deciding whether the water is suitable for drinking purpose or not. In the present study the lowest value of TDS are 160mg L<sup>-1</sup> and the highest value of 600mg L<sup>-1</sup> (Fig.3). All the result was below the permissible limit prescribed by WHO as 600 mg L<sup>-1</sup>.

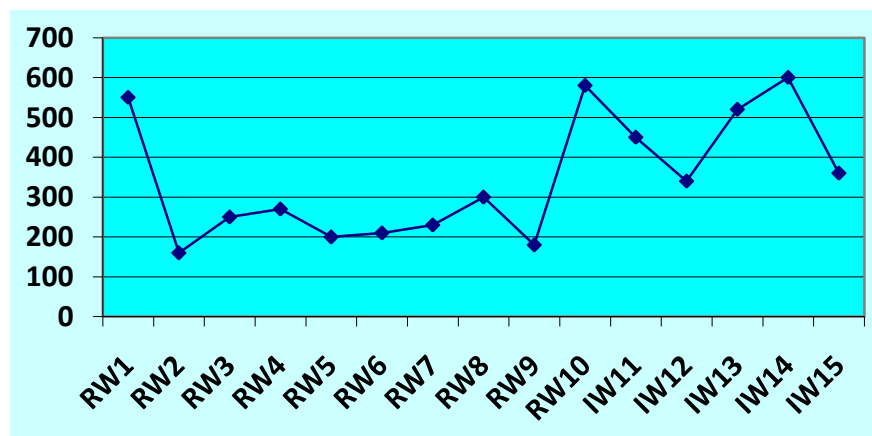


Fig 3

**Total Hardness:** In the present study the TH of water (Fig 4) was found to be 320 to 760 mg L<sup>-1</sup>. The highest value was found 760 mg L<sup>-1</sup> at sampling location RW1 (Dhawari) and lowest value was found 320 mg L<sup>-1</sup> at sampling location RW2 (Jawahar nagar) most of sampling stations were found higher values of hardness higher than the prescribed limits.

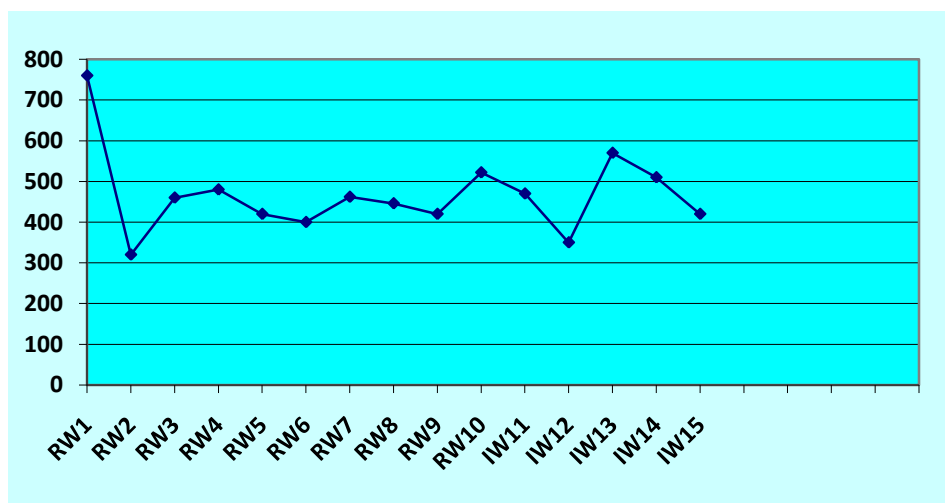


Fig 4

**DO:** The DO value (Fig 5) ranges from 3.90 mg L<sup>-1</sup> to 5.92mg L<sup>-1</sup>. The highest DO was observed at (5.92mg L<sup>-1</sup>) RW8 (Khermai Mandir) and lowest value was recorded at sampling station IW11 (Birla cement plant). Kataria(1990) noted DO 0.18 to 9.6 mg/l in bore well water of Bhopal[18].

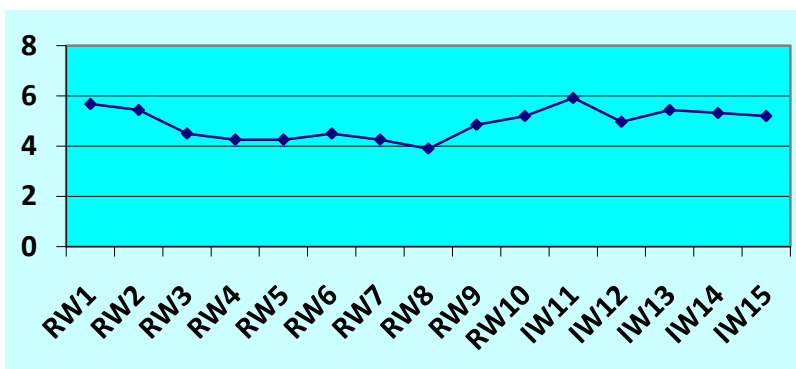


Fig 5

**BOD:** The BOD values (Fig 6) range from 3.95 mg L<sup>-1</sup> to 7.02 mg L<sup>-1</sup>, the highest BOD was observed (7.02 mg L<sup>-1</sup>) at sampling station RW8 while lowest value was observed (4.12) at sampling station IW11. Khan et al (2004) studied ground water quality of Nanded city and reported BOD value from 0.72 mg L<sup>-1</sup> to 6.12 mg L<sup>-1</sup> [19].

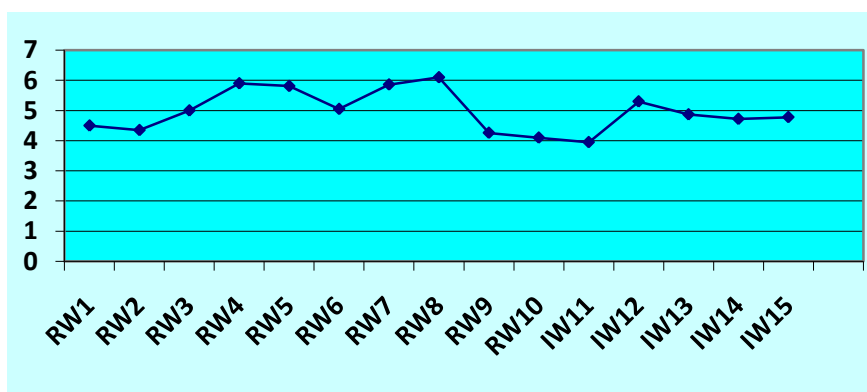


Fig 6

**COD:** The COD value (Fig 7) range form 1.33 mg L<sup>-1</sup> to 29.33 mg L<sup>-1</sup>. The value of COD at sampling stations RW1 Dhawari (17.33),RW2 Jawaharnagar (29.00), RW3 Civil line (22.60), RW5 Pashupatinath Mandir (25.38), RW6 Sohawal (20.00), RW9 Bus stand (16.00)and RW10 Eklavya Colony (12.66) are higher than the permissible limit prescribe by BIS and WHO as 10mg L<sup>-1</sup>.

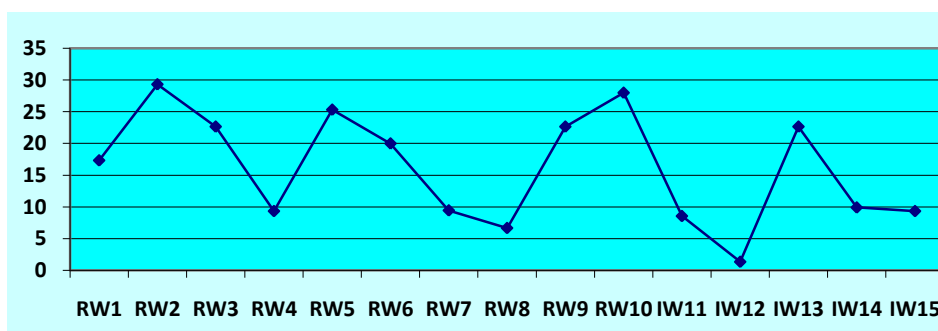


Fig 7

**Nitrate:** The nitrate value (Fig 8) ranges from 6.1 mg L<sup>-1</sup> to 30.0 mg L<sup>-1</sup>. The highest nitrate value was recorded (30.0 mg L<sup>-1</sup>) at sampling station IW13 (UCL Bardadeeh) while the lowest nitrate value was observed (6.1 mg L<sup>-1</sup>) at sampling station IW12 (Sagma). All the results were below the permissible limit prescribed by WHO as 45 mg L<sup>-1</sup>. Madhuri et al (2004) studied in ground water quality in commercial areas of Vishakhapatnam and reported Nitrated concentrations exceeds the guideline value (40 mg L<sup>-1</sup>) in some of the sample [20, 21].

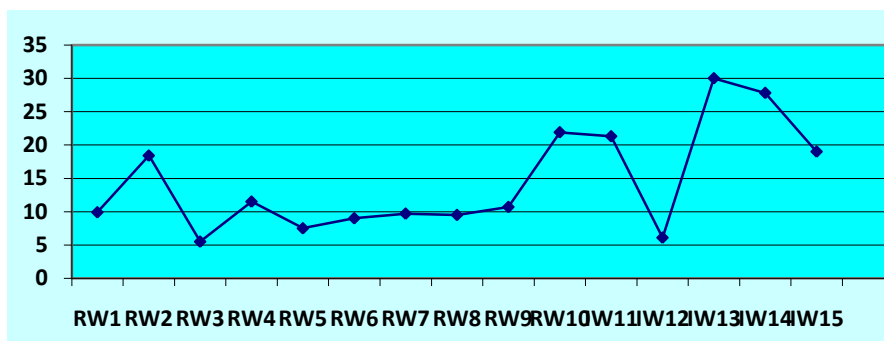


Fig 8

**Sulphate:** The sulphate value (Fig 9) ranged from 50 mg L<sup>-1</sup> to 148mg L<sup>-1</sup>. All the sulphate values were recorded with in the permissible limit prescribed by WHO[22] as 250mg L<sup>-1</sup>. Jaisawal et al (2008) Studied pre are post monsoon variation in physico-chemical characteristics of ground water quality of Bhopal and reported Sulphate content all the ground water quality under prescribed limits[23].

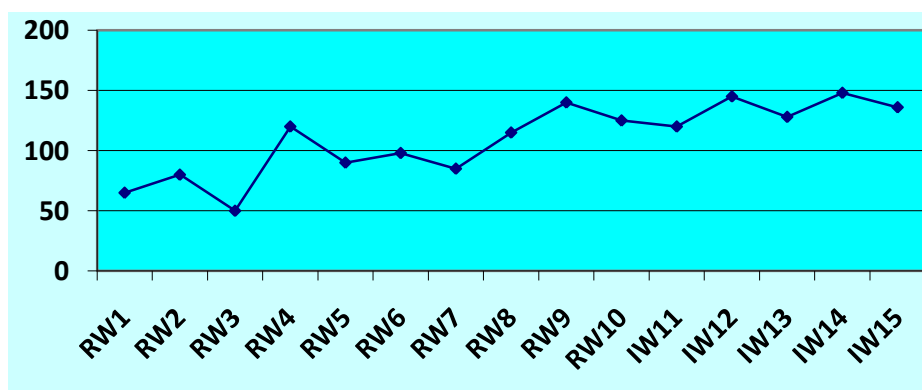


Fig 9

## APPLICATIONS

The present work emphasize on proper treatment of industrial waste water and their management. Therefore, it is useful for district administration for the feature planning of Municipal Corporation waste disposal.

## CONCLUSIONS

Present work done on ground water of Satna district covering various inorganic non metallic constituents covered are pH, TDS, TH, DO, BOD, COD, Nitrate, Sulphate. The temperature changed between 25 to 35, pH 7.10 to 8.90, TDS 160 to 600 mg L<sup>-1</sup>, DO 3.90 to 5.92, BOD 3.95 to 6.10, COD 1.33 to 29.33, Nitrate



6.1 to 30.0 mg L<sup>-1</sup> and Sulphate 50 to 148 mg L<sup>-1</sup>. Most of the samples TDS and COD are higher than the permissible limit, and TH of the entire water sample are higher than the permissible limit prescribed by WHO as 300 mg L<sup>-1</sup>. Nitrate and Sulphate of all the result within the WHO recommended values as 45 mg L<sup>-1</sup> and 250 mg L<sup>-1</sup> respectively. It is concluded that the ground water of Satna district are not highly contaminated, but there is an indication of increasing pollutant due to discharge of industrial effluents on land and surface water bodies.

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