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Determination of Water Quality Index of groundwater from some locations in Gwalior city

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Abstract: This study has been carried out to assess the water quality index of some important locations in Gwalior city for which total 12 locations were selected for sampling of groundwater samples. Attempts were made to study and analyze the physico-chemical and bacteriological characteristics of the water. Various parameters like pH, Total Dissolved Solids, Alkalinity, Acidity, Total Hardness, Chloride, Turbidity, Sulphate, Iron, Dissolved Oxygen, Biochemical Oxygen Demand and MPN are determined in laboratory. Observations reveal that some parameters like Hardness, TDS and MPN exceeds the permissible limits laid down for water (dinking purpose) as per IS: 10500-2012 hence supplied water does not satisfy the requirements for drinking purpose at most of the locations. To reflect the quality of water, water quality index (WQI) is calculated and it is found that the WQI values range from 47.598-64.524 in summer season and 45.443- 59.972 in rainy season. According to WQI values, water samples were rated in range of "Good to Poor" quality. The high value of WQI at locations could be attributed to the higher values of Hardness, TDS and MPN in the groundwater. The results of analysis are correlated with existing conditions in the vicinity of sampling stations. Results show that the groundwater of the city needs proper and adequate degree of treatment before distribution. Groundwater resource also needs to be protected from the risk of contamination & pollution. Thus, the results of the study are alarming from the point of view of public health. Continuous water quality monitoring along with suitable treatment must be at high priority coupled with regular & proper quality management of water supply.

Index Terms— Underground water, water quality index, physical & physico-chemical parameters, MPN, IS: 10500-2012, Grab samples.

I. INTRODUCTION

Water is one of the most widely circulated and abundant substances found in nature. Around two third area of the earth is covered with water but most of this water cannot be used for drinking purpose, because 97% of available water is saline and only 3% is fresh water. Out of 3% of fresh water, 2% is placed in the polar ice caps and glaciers, remaining 1% water is available for potable use. Further, due to pollution and contamination, quality of this 1% water is getting degraded constantly. Water quality is a measure to know how water is suitable for a particular purpose [1]. The better the water quality, for more applications it can be used with minimal treatment. The physico-chemical and bacteriological characteristics of groundwater can be a tool to assess suitability of water for agricultural, industrial, and domestic usages. People in the rural areas depend on water supply from untreated groundwater resources. In most of the cases groundwater is used for domestic use without quality check and treatment. Much of the current concern about rural public is focused on water because of its importance in maintaining the human health and ecosystem. As per studies about 2.5 billion people do not have access to adequate sanitation services and about one billion people are lacking to access of safe drinking water [2]. Furthermore, fresh water is a finite resource which is essential for agriculture, industry and even for human existence. Without fresh water of adequate quantity and quality, sustainable development is not possible [3]. But due to Rapid urbanization (especially in developing countries like India) quality of groundwater is becoming poorer due to its over-exploitation and improper waste disposal, particularly in urban areas. According to WHO, about 80% of all the diseases in human beings are caused by supply of unsafe water. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants [4]. Therefore, assessment of water quality of groundwater sources need to be given due attention before distribution. In this context water quality index (WQI) can be an effective tool to assess quality of water. It is a dimensionless number that combines multiple water quality factors into a single number and helps in interpreting the quality of water with a single numerical value. The objective of the present study is to provide information on the physico-chemical and bacteriological characteristics of the groundwater sources of the various locations in the city.

A. Study area

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Gwalior is one of the historical city of central India. It is located in the northern part of Madhya Pradesh state at 26.22ºN latitude & 78.18ºE longitude and covers an area of 780 sq.km with a population of 10.7 lacs (2011 census). It has an average elevation of 197 meter from the mean sea level. Gwalior has a sub-tropical climate with hot summers (March to June), the humid monsoon season (July to mid-October), and a cool dry winter (November to February). Gwalior is surrounded by industrial areas like Malanpur, Birla Nagar, Banmore, Baraghata, Ghirongi, Maharajpura etc. The major industries that are located in vicinity of Gwalior are agro based, chemical, textile, metal based, mineral based, food, wood furniture, m/c repairing & engineering units etc. Apart from this, some minor small scale industrial clusters are also located within municipal limit of the city. Some of these industries are pouring their treated/untreated effluent on land in unscientific manner this is causing soil and water pollution, thereby hampering water quality of ground water sources in many locations in city. Situation gets worsened because ground water without any treatment is directly being used for public water supply in some areas. Further this practice is putting large population of city at greater risk of health. Therefore, study is taken up to assess the ground water quality of some important locations in Gwalior city to know about prevailing water quality of water supply. In this study ground water samples from 12 locations (which include 3 of each residential, commercial, institutional and industrial areas) were collected in Gwalior city.

The locations of these sampling sites are shown in fig-1 and details are mentioned in the Table-1 for quick review.

Fig-1 (showing location of sampling sites)

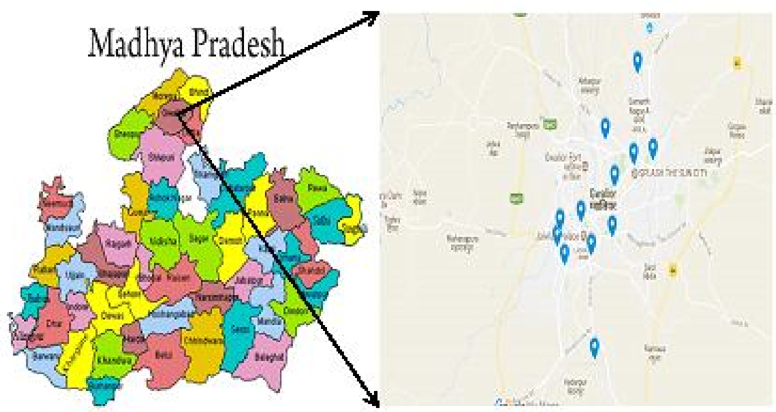

Table-1 Details of locations of sampling sites

Sample No.	Location	Source	Latitude	Longitude
S_1	Girls hostel No. 4 MITS college Gole ka mandir	Deep bore well	26.229770ºN	78.209580ºE
S_2	Near canteen KRG college Kampoo	Deep bore well	26.191698ºN	78.154802ºE
S_3	Near library Science college Chetakpuri	Deep bore well	26.195980ºN	78.173978ºE
S_4	Office of fire brigade, Maharaj bada	Deep bore well	26.199601ºN	78.148234ºE
S_5	Near MP PHED dept. City center	Deep bore well	26.203512ºN	78.192068ºE
S_6	D.D.Mall ground floor,Phool bagh	Deep bore well	26.209440ºN	78.166448ºE
S_7	Dipasha terrace multi Nai sadak	Deep bore well	26.205496ºN	78.150844ºE
S_8	Shital water supplier, Murar	Deep bore well	26.218813ºN	78.221727ºE
S_9	Near Maa Vindhywashni Mandir D.D.Nagar	Deep bore well	26.267323ºN	78.207750ºE
S_{10}	Grover tempo transport service, Hazira	Deep bore well	26.229312ºN	78.187791ºE
S_{11}	Indusial area near NRI College	Deep bore well	26.161975ºN	78.179024ºE
S_{12}	Kanch mill RD Behind Agriculture College	Deep bore well	26.223603ºN	78.190613ºE

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II. MATERIALS AND METHODOLOGY

A. Sample collection

Samples from twelve locations are collected during the month of March to May 2018 (summer season) & June to August 2018 (Rainy season). Samples for physico-chemical analysis were collected in plastic bottles of capacity 2 liters each. Sampling bottles were washed with 2% of nitric acid and then rinsed 3 times with distilled water. For bacteriological analysis samples were collected in sterilized glass bottles. Before collecting samples, water stored in the pipes was pumped out and outer rim of tap outlets was sterilized by flaming spirit soaked cotton swab for 2 minutes and then allowed it to cool down. Such samples are stored in ice box till transferred to Institute laboratory. In Institute the samples are stored in refrigerator at temperature below 4ºC.All the samples are analyzed within 6-10 Hours after collection hence preservatives are not used. Samples were collected from each site during morning hours and properly labelled & marked.

B. Physico-chemical and microbial parameters

The collected water samples were analyzed for various physico-chemical and bacteriological parameters. Parameters like MPN, DO and BOD testing were started first (within 2 hours of collection) and then remaining parameters were determined within 10 hours. The procedure for analysis was followed as per standard method of analysis of water and waste water (CPCB water and wastewater guideline, Indian Standard method, IIT Bhubaneswar environment laboratory manual and NITTTR Chandigarh manual). The experimental values of all parameters are taken as the average of 3 observations for each test. The values obtained were compared with standards given by BIS, WHO and ICMR.

Instrument/equipment & methods used for determination of various parameters are mentioned in Table-2
Table-2 Details of Instrument/Equipment & methods used for determination of various parameters

S.No.	Parameters	Instrument/Equipment used	Method adopted
1	pH	Potentiometer	Electrometric method
2	Total Dissolved Solid (TDS)	Drying oven, Digital balance machine, Desiccator, Filter paper	Gravimetric method
3	Total Hardness	Burette, Pipette, Conical flask, Measuring cylinder	EDTA Titrimetric method
4	Alkalinity	Burette, Pipette, Conical flask, Measuring cylinder	Neutralizing by standard $0.02NH_2SO_4$
5	Acidity	Burette, Pipette, Conical flask, Measuring cylinder	Neutralizing by standard NaOH
6	Chloride	Burette, Pipette, Conical flask, Measuring cylinder	Argentometric method
7	Sulphate	UV-visible Spectrophotometer(420nm), Hot plate with magnetic stirrer	Turbidimetric method
8	Iron	UV-visible Spectrophotometer(510nm), Soxhlet apparatus	Phenanthroline method
9	Turbidity	Nephelo turbidity meter	Turbidity method
10	DO	Burette, Conical flask, BOD bottles	Modified Winkler's method
11	BOD	BOD incubator, Burette	Modified Winkler's method
12	MPN	Bacteriological incubator, laminar flow, Micro pipettes, Autoclave, Hot air oven	Multiple tube with serial dilution (observing colour change at 24 and 48 hours)

C. Chemicals and Reagents

All the chemicals and reagents used for analysis were of analytical grade (A R Grade) and instruments were of adequate degree of precisions. All the chemical solutions were prepared by using double distilled water.

Water quality standards laid down by BIS: 10500-2012 are used to find out weightage of different parameters. Limits of various parameters are mentioned in Table-3 along with calculated values of weightage factors.

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Table-3 Standards given by Bureau of Indian Standards (BIS: 10500-2012) & WHO for drinking water

PARAMETER	STANDARD VALUE	WEIGHTAGE (Wi)
pH	8.5*	0.0291
TDS	500.0*mg/l	0.000494
Total Hardness	200.0*mg/l as $CaCO_3$	0.00123
Alkalinity	200.0*mg/l as $CaCO_3$	0.00123
Chloride	250.0*mg/l	0.00098
Sulphate	200.0*mg/l	0.00123
Iron	0.3*mg/l	0.823
Turbidity	5.0*NTU	0.0494
DO	5.0** mg/l	0.0494
BOD	6.0**mg/l	0.0412

*= Bureau of Indian Standards (BIS: 10500-2012), **= World Health Organization

D. Water Quality Index

On the Basis of concentration of various parameters of water it is difficult to compare or rate the quality of water. Therefore, a numerical index called water quality index (WQI) is commonly used which reflect or rate the quality of water samples. Water quality index is dependent on the parameters selected for the study. For the calculation of WQI ten parameters are selected. Values used for each parameter are the mean value of 3 observations of each parameter. The water quality index has been calculated by using the weighted arithmetic index method. WQI indicates the quality of water in terms of index number which represents overall quality of water for any specific use. It is defined as a rating and reflecting the composite influence of different water quality parameters on the overall quality of water. The indices are amongst the most effective ways to communicate the information on water quality supplied to the general public or to the policy makers for water quality management. In formulation of water quality index the assigned 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.

Calculation of WQI: First the quality rating scale (Qi) for each parameter was calculated by using the following equation

$$Qi = \left[\frac{Va - Vi}{Vs - Vi}\right] \times 100$$

Where, Qi = Water quality rating of the i^{th} parameter.

Va= Actual value of the i^{th} water quality parameter obtained from the analysis

Vi = Ideal value of i^{th} parameter in pure water (Ideal value is 7 for pH and for DO ideal value is 14.6 except these Ideal value is 0 for other parameters).

Vs = Standard permissible value for the i^{th} parameter

The relative unit weight (Wi) was calculated by a value inversely proportional to the recommended standard value (Si) of the corresponding parameter by using following equation:

$$Wi = \frac{K}{Si}$$

Where, Wi= Unit weight for the i^{th} parameter

Si = Standard permissible value of the parameters

K = Proportionality constant

$$K = \frac{1}{\sum_1^i Si}$$

The Overall Water Quality Index (WQI) was calculated by aggregating the quality rating with the unit weight linearly by using the following equation:

$$WQI = \frac{\Sigma WiQi}{\Sigma Wi}$$

Where, Qi= Quality rating

Wi= Unit weight

E. Assessment of water quality

According to water quality index, the water is rated in five classes. Table-4 represents the five classes of water quality based on (Arithmetic WQI) Table -4 Water quality index (WQI) range, grading and possible usage of the water

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Water Quality Index Value	Rating of water quality	Classes	Possible uses
0-25	Excellent	A	Drinking, irrigation and industrial
26-50	Good	B	Drinking, irrigation and industrial
51-75	Poor	C	Irrigation and industrial
76-100	Very poor	D	Irrigation
>100	Unsuitable for drinking purpose	E	Proper treatment required before use

III. OBSERVATIONS AND RESULTS

The level of the measured physico-chemical and bacteriological parameters for the drinking water samples are in the tables given below for both the seasons.

Table-5 physico-chemical analysis results of all the samples during March-May (summer season) 2018

S. No.	Parameters	Standard values (BIS and WHO)	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}
1	pH	6.5-8.5*	7.9	7.4	7.4	7.5	7.1	7.8	7.7	7.4	7.2	6.9	7.4	7.4
2	Alkalinity (mg/l as $CaCO_3$)	200*	118.6	130.6	80.0	94.67	160	89.33	76.0	104	164	73.33	86.6	148
3	Acidity (mg/l as $CaCO_3$)	-	34.67	36.0	37.3	36.0	60.0	46.6	33.33	33.3	40.0	29.33	36.0	49.33
4	Total Hardness (mg/l as $CaCO_3$)	200*	466.6	176.6	200	130.6	366.6	266.6	166.6	245	308.3	146.6	275	341.6
5	Chloride (mg/l)	250*	237.5	117.5	100	78.75	137.5	68.75	81.26	81.24	174.9	75.0	150	153.7
6	TDS (mg/l)	500*	1385	1012	620	473	647	1147	946	445	859	442	515	811
7	Iron (mg/l)	0.3*	0.17	0.15	0.15	0.14	0.17	0.16	0.16	0.16	0.16	0.17	0.2	0.18
8	Sulphate (mg/l)	200*	28.51	20.29	22.9	23.36	16.83	13.36	14.07	12.3	24.65	27.43	41.98	35.54
9	Turbidity (NTU)	5*	3	3	3	2	3	3	2	3	3	3	2	3
10	DO (mg/l)	5**	6.0	4.2	1.6	2.2	3.0	7.0	6.5	4.4	3.8	2.5	6.7	3.4
11	BOD (mg/l)	6**	1.5	0.7	0.0	0.2	0.5	3.0	2.3	0.0	0.8	0.8	1.6	0.4
12	MPN (colonies/100 ml water sample)	0**	7	5	9	<2	4	2	5	<2	4	5	<2	9

*= Acceptable value given by Bureau of Indian Standard, **= Acceptable limit given by World Health Organization

Table-6 physico-chemical and bacteriological analysis results of all the samples during June-August (rainy season) 2018

S. No.	Parameters	Standard values (BIS and WHO)	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}
1	pH	6.5-8.5*	7.5	7.1	7.2	7.2	7.0	7.4	7.3	7.1	7.1	7.0	7.2	7.1
2	Alkalinity (mg/l as $CaCO_3$)	200*	110.6	115.8	70.0	84.28	142.6	80.0	66.8	94.0	146.6	60.0	81.32	140.6
3	Acidity (mg/l as $CaCO_3$)	-	30.66	31.9	33.3	31.0	52.0	37.5	30.6	29.3	32.0	22.0	30.6	42.6
4	Total Hardness (mg/l as $CaCO_3$)	200*	425.0	163.3	183.5	122.5	300.0	233.8	153.3	212.5	283.8	130.0	248.3	321.6
5	Chloride (mg/l)	250*	206.2	108.7	88.7	73.1	132.4	64.9	75.0	77.5	161.3	63.0	137.5	135.0
6	TDS (mg/l)	500*	1247	938	584	445	589	1078	869	376	803	411	463	765
7	Iron (mg/l)	0.3*	0.16	0.14	0.14	0.13	0.15	0.14	0.15	0.15	0.15	0.16	0.18	0.16
8	Sulphate (mg/l)	200*	26.23	18.16	19.37	20.07	14.23	12.97	13.46	11.01	21.36	23.36	38.83	32.19
9	Turbidity (NTU)	5*	4	4	5	3	4	3	3	4	4	4	4	5
10	DO (mg/l)	5**	6.5	4.7	2.0	2.6	3.8	7.6	6.9	4.8	4.3	3.0	7.2	4.0
11	BOD (mg/l)	6**	1.1	0.2	0.0	0.0	0.3	2.0	1.5	0.0	0.3	0.5	1.0	0.0
12	MPN (colonies/100 ml water sample)	0**	5	7	5	2	5	4	2	4	5	7	4	5

*= Acceptable value given by Bureau of Indian Standard, **= Acceptable limit given by World Health Organization

In the study, water sample collected from 12 stations and tested for 12 physico-chemical parameters than the results were compared with Indian standard. The WQI of all the samples lies in the range of "good to poor". In summer only sample S_4 comes under the range of <50WQI, and all other samples shows WQI above >50. In rainy season excluding sample S_2, S_4 and S_6 all the samples have the WQI value >50. Table 7 shows the values of WQI of water samples collected from twelve locations during summer and rainy seasons.

Table- 7 water quality index during summer and rainy season

Station	WQI(summer season)	WQI(rainy season)	Station	WQI(summer season)	WQI(rainy season)
S_1	60.057	55.576	S_7	53.386	50.821
S_2	51.120	48.320	S_8	53.782	50.915
S_3	52.960	51.897	S_9	56.332	53.215
S_4	47.598	45.443	S_{10}	57.562	53.613
S_5	56.915	53.504	S_{11}	64.524	59.972
S_6	56.446	49.975	S_{12}	60.775	57.436

IV. DISCUSSION

A. pH

pH is the measure of negative logarithm of hydrogen ion concentration in a solution. The pH scale lies in the range of 0-14. Water having pH 7 is neutral, less than 7 is acidic and greater than 7 is alkaline. pH below 4 gives sour taste to water and pH above 8.5 gives bitter taste to water. The pH value of natural water changes not only by the reaction of carbon dioxide but also due to the biological activity. Any alteration in water pH leads to change in other physico-chemical parameters. Maintaining the pH is one of the most important requirement of any aquatic system since all the biochemical activities depend on pH of the surrounding water. The pH value of collected water samples were in the range of 6.9-7.9 which are within the acceptable limit given by BIS.

B. TDS

TDS gets its way in groundwater when it passes through the soil strata and dissolves the minerals present in the soil. Total dissolved solids are the total amount of mineral, salts and metal dissolved in the water. TDS is directly related with the quality of water and efficiency of water purification system. Use of high TDS water for drinking purpose may leads to many diseases in humans like kidney stone, arthritis and high concentration may also affect the person who are suffering from heart disease. TDS of all the samples were in the range of 442-1385 mg /l in summer season and 376-1247 mg/l in rainy season. TDS value is higher at station S_1 (1385 mg/l) and lowest value at station S_8 (376 mg/l). Most of the sample results reveals that the TDS in water is more than the acceptable limit 500 mg/l as recommended by BIS.

C. Total Hardness

Total hardness is the measure of calcium and magnesium ions present in the water. Hard water causes problem like scale formation in pipe lines, boilers tubes, sinks, dish washer, also may stain clothing .Regular drinking of hard water may causes problem of kidney stone in humans. Total hardness of all the samples were in the range of 130-466 mg/l as $CaCO_3$ in summer season and 122.5-425 mg/l in rainy season. The acceptable limit of hardness is 200 mg/l as $CaCO_3$ recommended by BIS. At few locations (S_1, S_5, S_6, S_8, S_9, S_{11}, S_{12}) the hardness in samples exceeds BIS limits during both seasons.

D. Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD) is the measures of the oxygen required by the microorganisms for decomposition of organic matter. In drinking water BOD value is almost negligible, if it shows value greater than 5 mg/l it means water is doubtful in purity. Efficiency of wastewater treatment plants is judged by considering influent and effluent BOD values. In present study BOD values in water samples are found to be 0-3 mg/l in summer season and 0-2 mg/l in rainy season. Thus, BOD values of all locations are within WHO acceptable limit (6 mg/l).

E. Sulphates

Rain water found its way from the soil strata that contains sulphate ions and most of these ions are also soluble in water. Many sulphate ions in to ground are produced by oxidation process and sulphate bearing minerals of their ores, and may also be present in industrial wastewater. The method to measure quantity of sulphate is by UV Spectrophotometer. All the water samples contain sulphate in the range of 12.76-41.98 mg/l in summer season and 11.013-38.832 mg/l. It means all the samples results are within BIS acceptable limit (200 mg/l).

F. Chloride

It is present in the water and wastewater as salts of Calcium, Magnesium and Potassium ions. Chloride (sodium chloride ions) gives salty taste to water and in boilers it creates problems after heating because magnesium chloride in water generates hydrochloric acid which is highly corrosive. It can also corrode the water supply and sewage pipes made of concrete. All the water samples were found to contain chlorides in the range of 75-237.5 mg/l during summer season and 64.98-206.25 mg/l during rainy season. It means that all the samples have chlorides within BIS acceptable limit (250 mg/l).

G. Iron

Iron (5%) is the fourth most abundant element available on the earth crust after Oxygen (46.6%), Silicon (27.7%) and Aluminum (8.1%). Our body needs iron to make Oxygen carrying proteins like hemoglobin (present in red blood cell) and myoglobin (present in muscles). Human can take 5 mg/l iron daily without any health effect. Iron of all the water samples were in the range of 0.14-0.2 mg/l in summer season and 0.13-0.18 mg/l in rainy season. For all water samples iron level is within the acceptable limit 0.3 mg/l given by BIS.

H. Alkalinity

It is the potential of water's ability to neutralize acid. Alkalinity in natural water is primarily due to the presence of weak acid, salts. Although, strong bases may also contribute in the extreme environment. Alkalinity comes in groundwater from soil strata and dissolve in it while percolation through the soil strata. It is measured by titration method with standardized acid up to a pH value of 4.5. In the present investigation the total alkalinity of the water samples is found in the Range 73.33-164 mg/l as $CaCO_3$ in summer season and 60-146.68 mg/l as $CaCO_3$ in rainy season. All the water samples shows alkalinity within the BIS acceptable range (200 mg/l as $CaCO_3$).

I. Turbidity

Turbidity is the cloudiness of water caused by suspended solids that are usually invisible to the naked eye. It is an aggregate optical property of the water and does not identify individual substances. It just says something is there in water. Turbidity indicates the presence of dispersed and suspended solids like silt, clay, organic matter and other microorganisms. Turbidity gives bad taste and odour to water and also it increases the load on the slow sand filters. Water samples from all locations show turbidity values in the range of 2-3 NTU in summer season and 3-5 NTU in rainy season, which means that turbidity in all the samples are within BIS acceptable limit (5 NTU).

J. Dissolved Oxygen

Dissolved oxygen is the most important indicator of the health of the water bodies. Wastewater released from industrial outlets and sewers can reduce dissolved oxygen levels. The minimum DO level desirable for survival of aquatic life is 4-5 mg/l. Dissolved oxygen play an important role in the survival of aquatic life at high temperature in lakes and reservoirs during summer month. The DO values observed in the present study are within 1.6-7 mg/l in summer season and 2-7.6 mg/l in rainy season. In most of the locations D.O. value in water samples (S_2, S_3, S_4, S_5, S_8, S_9, S_{10}, S_{12}) is less than the prescribed limit.

V. CONCLUSION

During the study it is found that maximum value of WQI was at station S_{11} and minimum value of WQI found at station S_4 in both summer and rainy seasons. At station S_{11} (Industrial area near NRI college) water quality is poor which shows probability of mixing of industrial effluent with groundwater. Station S_4 (Maharaj Bada) which is a commercial area and is in the center of the city, no industry is situated near close proximity. Here the water quality index of groundwater ranges from 47.598-64.524 in summer season and 45.443-59.972 in rainy season. The WQI value is higher in summer season as compare to rainy season, it may be due to rain water (good quality water) which dilute the polluted groundwater. From the results it can be concluded that at all locations, parameters like- BOD, Turbidity, Alkalinity, Chloride, Iron, Sulphate and pH values are within the acceptable limit given by BIS and WHO. However, the parameters like TDS, Hardness and MPN values are found to exceed the acceptable limit at most of the locations. Therefore, the parameters for which treatment is needed prior to use are Hardness, TDS and MPN. High concentration of Hardness and TDS comes in the water due to the leaching of minerals present in soil strata. High value of MPN shows that water may be getting contaminated by intrusion of untreated sewage into the ground or by rain water that infiltrates into the soil strata. High concentration of Hardness may lead to the problem of scale formation and in humans it may cause problem of kidney stone. High levels of TDS may leads to many diseases which are not water-borne but are due to excess salts. MPN may directly trigger water borne diseases like typhoid, cholera, diarrhea etc. Water from all the locations needs to be treated before use. Treatment like softening, chlorination and disinfection need to be provided. Water supply from Tigra dam contains low TDS & Hardness hence as one of the solution Tigra water may be mixed with groundwater supply to dilute TDS & Hardness to an extent so that concentration of TDS & Hardness of mixed water falls below acceptable limits. At present there is no system exists to monitor quality of groundwater supplies. There is an urgent need to renew water or sewage pipes to avoid sewage infiltration in water distribution network and monitor quality of groundwater regularly at consumer ends.

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