GROUND WATER QUALITY OF LUCKNOW CITY

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Abstract: Without water life is not sustainable on earth. Primarily the ground water was safe to drink but after the time was passed it became polluted due to huge discharge of untreated industrial effluent and other human activities. Polluted water is mostly responsible for diseases like hepatitis, jaundice, typhoid dysentery and diarrhoea etc. Surface water and Groundwater both are the source of drinking water in the Lucknow city, the capital of Uttar Pradesh. The aim of this study is to know the current situation of ground water quality of Lucknow city. In this study 5 stations at Lucknow city have been selected for collecting ground water samples and comprehensive physico-chemical analysis was conducted. Physico-chemical Parameters like temperature, turbidity, conductivity, TDS, chloride, fluoride, total hardness, alkalinity, nitrate and phosphate were measured according to the standard method. The results were compared with IS drinking water standard 10500 and observed that most of parameters at all sampling station were found within acceptable limit while few parameter like TDS, total hardness, alkalinity and sulphate were found higher than standard limit at some of the stations.

***Key words*:** Ground water, physico-chemical, pollution, Lucknow

Introduction:-

The environmental pollution level is increasing day by day with the passage of time. Where ever the ground water is major source for providing water not only for drinking purpose but also for industrial and agricultural uses (Singh and Shukla, 2010). It is estimated that approximately one third of the world's population use groundwater for drinking (Ahmad and Mishra, 2014) so that the ground water is continuously being exploited (Singh and Shukla, 2010). Primarily the ground water was safe to drink but after the time was passed ground water gets polluted by leaching of chemical species e.g., phosphate, nitrate, pesticides and other toxic elements like heavy metals due to huge discharge of untreated industrial effluent through drains, agricultural septic tanks, domestic waste water and sulabh shauchalayas fields. Polluted water is mostly responsible for diseases like hepatitis, jaundice, typhoid dysentery and diarrhoea etc. (Siddiqui *et al.*, 2015).

80 cities of the Uttar Pradesh fulfil their needs for drinking and irrigation by ground water sources. Contamination of drinking water has become a major concern to the Environmentalist in the developing countries (Ahmad and Mishra, 2014).

Due to over exploitation of ground water by human for their own needs it has started to shrink. Ground water quality depends on use of land and quality of the waste water drained into the river of terrain. Due to our irresponsible behaviour quality of ground water is deteriorating day by day (Siddiqui. *et al.*, 2015).

Lucknow is the capital of Uttar Pradesh. The state Uttar Pradesh consists of two geomorphic units which is Ganga plains and Bundelkhand plateau (GWYBUP, 2014). All Around 85% of the land-area of Lucknow City is situated on the Central Ganga alluvial plain, and stretches across both banks of the Gomti River. The Lucknow city is underlain by a large thickness of Quaternary alluvial sands (at best of medium-grade) with occasional interbedded silty clay aquitards.

Water soaked into the ground because of gravitational force by passing through soil particles, sand, gravel which comes from rain, sleet, snow and hail that soak into the ground until it reaches a depth where Ground water occurs. We can define ground water as water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations (Kumar *et al.*, 2015).

It is estimated that India is using almost 230 Kl^3 of groundwater per year which is largest amount in the world (Shankar *et al.*, 2011).

Fresh and safe drinking water is our primary need and groundwater is most suitable fresh water resource (Ramesh and Thirumangai, 2014). The present study is an attempt to compare the quality of ground water like hand pump and bore well water with their prescribed standard and to determine the potability in terms of pH, TDS, chloride, Fluoride, alkalinity, total hardness, calcium, magnesium, sulphate, phosphate and nitrate, which was conducted by analyzing grab water samples from 5 different spots selected randomly during the October-December 2016.

Material and Method:-

Monitoring was carried out at 5 stations in the month of October 2016 to December 2016. Ground water quality was assessed to know the ground water quality status. Ground water source for sampling were bore well and hand pumps. The samples were collected in sampling bottles. The collected samples were analyzed for various physico-chemical parameters like Temperature (Temp.), pH, Turbidity (Turb.), Conductivity (Cond.), Total Dissolved Solids (TDS), Alkalinity (Alkal.), Chloride (Cl^-), Fluoride (F^-), Total Hardness (T.H.), Calcium (Ca^{++}), Magnesium (Mg^{++}), Sulphate (SO_4^{--}), Phosphate (PO_4^{--}) and Nitrate Nitrogen (NO_3^--N) and All the parameters were analysed as per Standard methods for examination of water and wastewater (APHA AWWA WPCF-2012).

Study Area:-

To assess Ground water quality of Lucknow City five stations were selected. Stations of sampling stations with their coordinates are given in Table-1.

Table -1 showing Sampling station with their GPS location

Station code	Stations	GPS Location
GW1	Teeley wali Masjid	**26º 52'17.1''N 80º 54'53.5''E**
GW2	Near Shani Mandir Qaisar Bagh	**26º 51'25.4''N 80º 56'10.5''E**
GW3	Near Lakshman Mela Ground, Nishat Ganj	**26º 51'36.8''N 80º 56'58.3''E**
GW4	Janeshwar Mishra Park ,Gomti Nagar	**26º 50'19.9''N 80º 59'50.3''E**
GW5	Near Sai Vitista Infratech, Shaheed Path	**26º 49'10.4''N 81º 00'44.2''E**

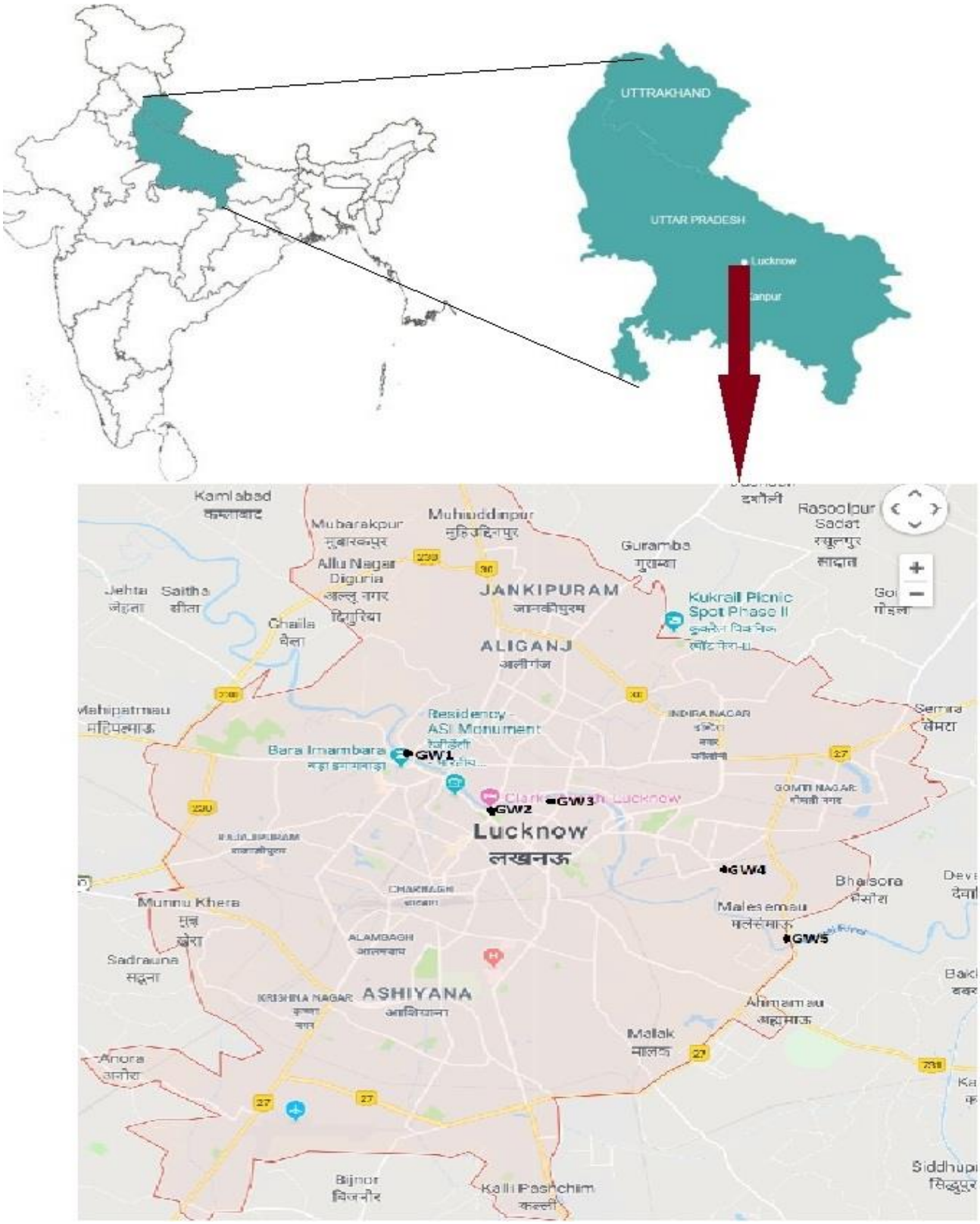


Figure -1 Map of Lucknow showing sampling stations

Result and Discussion-

Table-2 Showing average concentration of various physico- chemical parameter and standard deviation at diffrent sampling station

S.No.	Parameters and Unit	IS: 10500 Drinking Water Standards	GW1	GW2	GW3	GW4	GW5
1.	Temp. (ºC)	-	21.16±2.25	21.13±2.01	22.93±0.73	22.83±0.83	21.77±2.01
2.	pH	6.5-8.5	7.86±0.11	7.70±0.20	7.23±0.15	7.63±0.15	7.46±0.15
3.	Turb. (NTU)	1	< 1	<1	<1	< 1	<1
4.	Cond. (µmhos/cm)	-	617.67±19.13	344.33±11.15	1057.33±103.51	1030±49	2042.67±61.81
5.	TDS (mg/l)	500	320±20	263.67±5.13	580.44±4.51	533.40±10.52	1018.33±43.98
6.	Alkal. (mg/l)	200	225.67±6.02	156.67±3.05	244.33±4.04	371.67±11.23	355.0±5.0
7.	Cl^- (mg/l)	250	34.67±3.51	40.33±2.51	143.67±5.10	44.60±2.86	91.66±1.52
8.	F^- (mg/l)	1.0	0.19±0.25	0.04±0.01	0.22±0.28	0.06±0.01	0.29±0.37
9.	T.H. (mg/l)	200	131.66±7.63	135.0±5.0	291.66±10.40	97.43±2.45	255.33±4.50
10.	Ca^{++} (mg/l)	75	32.66±1.15	31.33±1.15	80.0±2.0	8.66±1.15	38.66±1.15
11.	Mg^{++} (mg/l)	30	12.13±2.13	13.8±0.69	22.3±1.83	18.4±1.22	38.57±0.58
12.	SO_4^{--} (mg/l)	200	0.40±0.02	10.20±0.30	40.26±1.25	3.20±0.26	232.33±3.01
13.	PO_4^{--} (mg/l)	--	0.0093±0.0005	0.019±0.001	0.0277±0.0032	0.018±0.0026	0.0187±0.0015
14.	$NO_3^{--}N$ (mg/l)	45	0.50±0.03	6.63±0.35	36.96±1.66	0.96±0.05	2.63±0.15

Table-3 Correlation between various physico-chemical

	Temp.	pH	Cond.	TDS	Alkal.	Cl^-	F^-	T.H.	Ca^{++}	Mg^{++}	SO_4^{--}	PO_4^{--}	NO_3^--N
Temp.	1.000												
pH	-0.706*	1.000											
Cond.	0.321	-0.522*	1.000										
TDS	0.330	-0.574*	0.996*	1.000									
Alkal.	0.554*	-0.247	0.773*	0.739*	1.000								
Cl^-	0.601*	-0.959*	0.490	0.531*	0.136	1.000							
F^-	0.038	-0.438	0.722*	0.706*	0.281	0.606*	1.000						
T.H.	0.326	-0.859*	0.590*	0.629	0.076	0.941*	0.778*	1.000					
Ca^{++}	0.274	-0.740*	0.128	0.169	-0.319	0.877*	0.557*	0.868*	1.000				
Mg^{++}	0.232	-0.587*	0.968*	0.985*	0.625*	0.543*	0.699*	0.673*	0.216	1.000			
SO_4^{--}	-0.039	-0.406	0.909*	0.922*	0.491	0.397	0.725*	0.608*	0.156	0.963*	1.000		
PO_4^{--}	0.674*	-0.925*	0.230	0.301	0.033	0.828*	0.089	0.674*	0.660*	0.341	0.155	1.000	
NO_3^--N	0.555*	-0.810*	-0.013	0.035	-0.254	0.863*	0.249	0.719*	0.910*	0.057	-0.091	0.834*	1.000

Note- *- is showing significant correlation

Temperature is directly related with the chemical reaction and biochemical reaction in the water and it's living organism (Kumar and Pal, 2010). In the past study it have been seen that variation in temperature is mainly related with the atmospheric temperature and weather conditions. Minimum Temperature was found 21.13^{o}C at Near Shani Mandir Qaisar Bagh (GW2) and Maximum was found at 22.93 ^{o}C Near Lakshman Mela Ground, Nishat Ganj (GW3).

Minimum pH was found 7.23 Near Lakshman Mela Ground, Nishat Ganj (GW3) and maximum was found at 7.86 at Teeley wali Masjid (GW1). pH was found within range at all stations during study. The pH of a water body is very important in determination of water quality since it affects other chemical reactions such as solubility and metal toxicity (Fakayode, 2005).

If the scattering of light is greater, the turbidity will be high. Low turbidity values indicate high water clarity; high values indicate low water clarity (Ahmad and Mishra, 2014). Turbidity was found less than 1.0 NTU at all stations which is under acceptable limit prescribed by BIS 10500-2012.

Electrical conductivity (EC) is an indicator of water quality and measures water's capacity to conduct electric current (Kumar *et al.*, 2015). Conductivity is also one of the good and rapid method for measuring the total dissolved ions and directly related to total solids. If the value of dissolved solids is higher than amount of ions also will be higher (Bhatt *et al.* 1999 and Khatoon *et al.* 2013).

Fig-2 Temperature °C

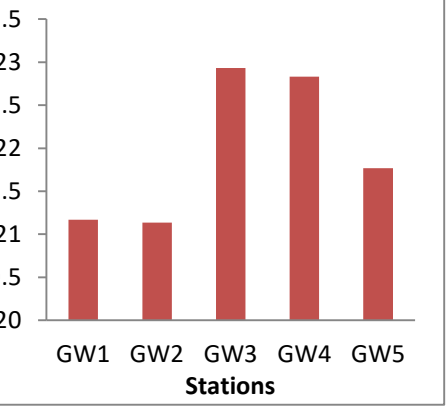


Fig-3 pH

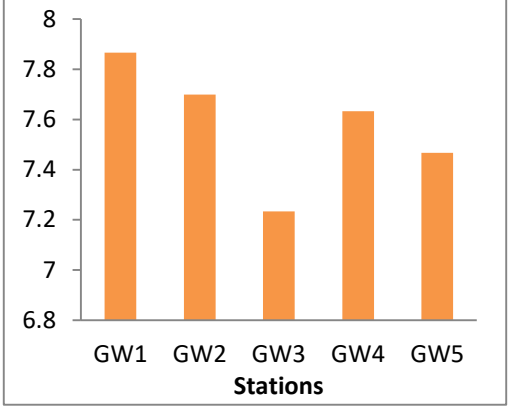


Fig-4 Conductivity

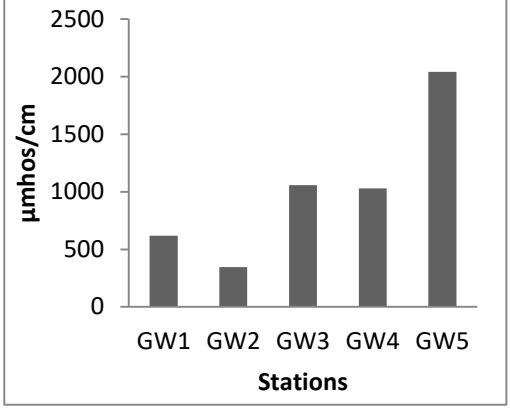


Fig-5 TDS

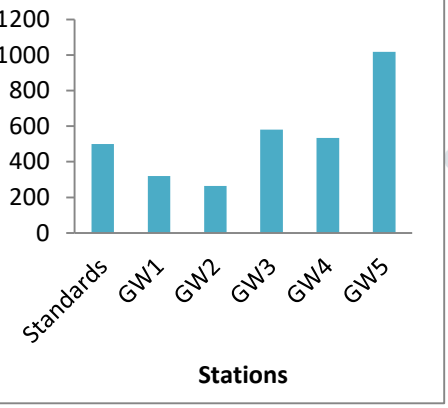


Fig-6 Alkalinity

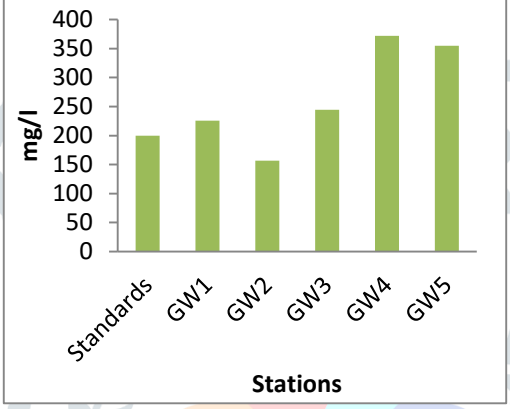


Fig-7 Chloride

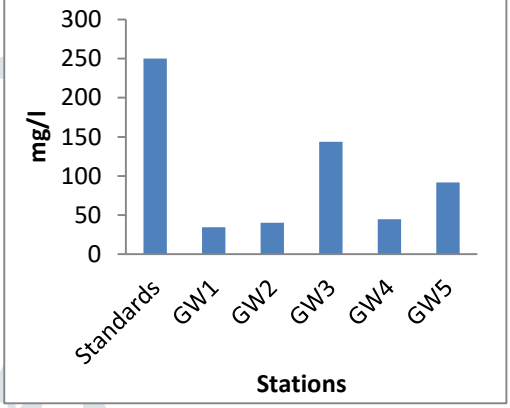


Fig-8 Fluoride

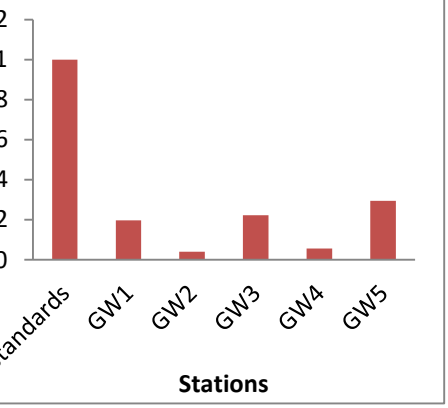


Fig-9 Total hardness

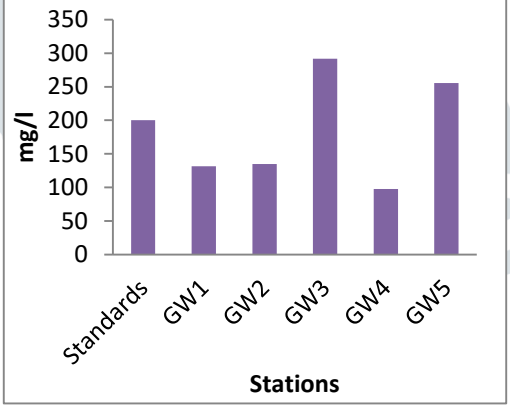


Fig-10 Calcium & Magnesium

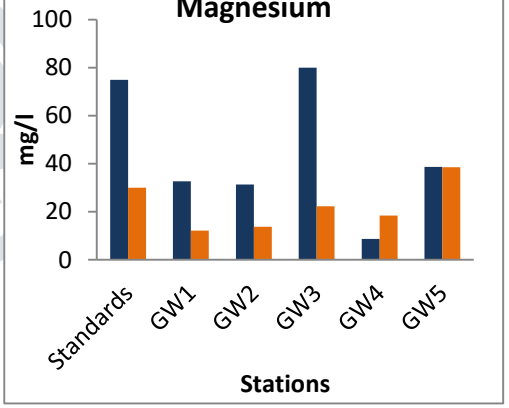


Fig-11 Sulphate

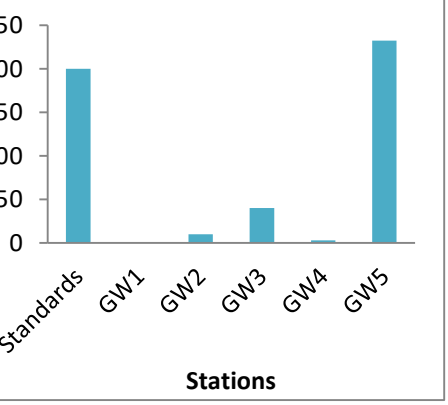


Fig-12 Phosphate

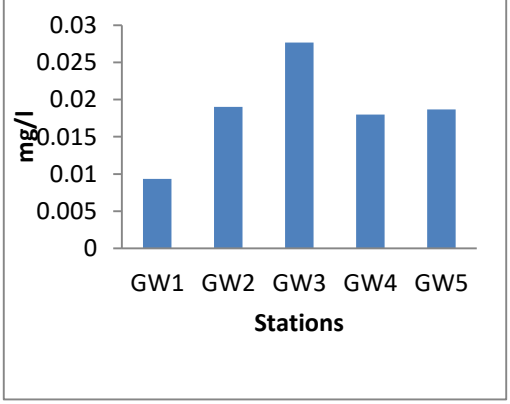
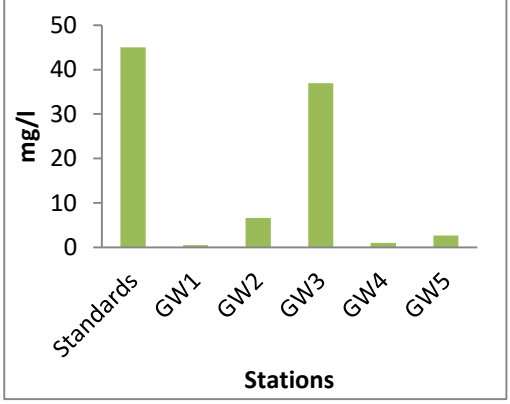


Fig-13 Nitrate



urbidity was found within t

Minimum conductivity was found 344µmhos/cm at Near Shani Mandir Qaisar Bagh (GW2) and maximum was found 2042.67 Near Sai Vitista Infratech, Shaheed Path(GW5).

The total dissolved solids are expressed by the weight of residue left when a water sample has been evaporated to dryness (Khatoon *et al.* 2013). Total dissolved solid refers to the material that is completely dissolved in water. Analysis of TDS values is important to determine whether the water is useful for drinking and agriculture purpose or not (Siddiqui. *et al.*, 2015). Total dissolved solid is particularly useful in the analysis of industrial waste water. It signifies the inorganic pollution load of water system (Usha *et al.*, 2008). Minimum total dissolved solids was found 263.66 mg/l at Near Shani Mandir Qaisar Bagh (GW2) and maximum was found 1018.33 mg/l at Near Sai Vitista Infratech, Shaheed Path(GW5).

The neutralizing capacity of acids in water without any significant change in the pH is known as alkalinity. The hydroxides, carbonates and bicarbonates are main source of the alkalinity of water (Kumar *et al.*, 2015). Minimum alkalinity was found 156.67 mg/l Near Shani Mandir Qaisar Bagh (GW2) and maximum was found 371.67 mg/l at Janeshwar Mishra Park ,Gomti Nagar (GW4) which exceeds the desired limits given by BIS (2012) i.e. 200 mg/L. Although, it don't cause any health effect, but when present in higher concentrations of more than 100mg/L, it gives bitter taste to water (Maiti., 2004).

Minimum chloride was found 34.67 mg/l Teeley wali Masjid (GW1) and maximum was found 143.67 mg/l at Lakshman Mela Ground, Nishat Ganj (GW3). Chloride was found within the range at all stations during study. Chloride contamination in ground water occurs mostly because of the chlorination of water for destroying harmful microorganisms present in water. When present in higher concentrations, it only imparts bitter taste but, don not cause any health problem (Kumar *et al.*, 2015). Drinking water with levels of chloride above 250 mg/L may cause corrosion in distribution systems and may be detectable by taste. The level of 250 mg/L of chloride is sufficient to reduce agricultural yield particularly from some fruit and berry bearing plants (Ahmad and Mishra, 2014).

Minimum fluoride was found 0.04 mg/l at Near Shani Mandir Qaisar Bagh (GW2) and maximum was found 0.29 mg/l at Near Sai Vitista Infratech, Shaheed Path(GW5).Fluoride was found within the range at all stations during study. Fluoride is considered as an essential element though health problems may arise from either deficiency or excess amount (Gopal et al, 1985). Fluoride concentration of 0.4 ppm in drinking water causes mild type of dental fluorosis (Dinesh, 1999; Gupta *et al.*, 1993; Yadav and Lata, 2004).

Hardness in water can be defined as the presence of multivalent metallic cations in the water. The most common salts are carbonates, fluorides and sulphates of calcium and magnesium (Kumar *et al.*, 2015). The hardness may be advantageous in certain conditions; it prevents the corrosion in the pipes, and reduces the entry of heavy metals from the pipe to the water (Shrivastava *et al.*, 2002). Minimum Total Hardness was found 97.43mg/l at Janeshwar Mishra Park ,Gomti Nagar (GW4) and maximum was found 291.67mg/l at

Lakshman Mela Ground, Nishat Ganj (GW3). Total hardness is used for describe the effect of dissolved mineral (Ca and Mg), to determine solubility of water for domestic, industrial and drinking purpose attributed to presence of bicarbonates, sulphate, chloride and nitrates of Calcium and Magnesium. Minimum Calcium was found 8.66 mg/l at Janeshwar Mishra Park ,Gomti Nagar (GW4) and maximum was found 80.0 mg/l at Lakshman Mela Ground, Nishat Ganj (GW3).Minimum Magnesium was found 12.13 mg/l at Teeley wali Masjid (GW1) and maximum was found 38.57 mg/l at Near Sai Vitista Infratech, Shaheed Path(GW5).

Minimum sulphate was found 0.40 mg/l at Teeley wali Masjid (GW1) and maximum was found 232.33 mg/l at Near Sai Vitista Infratech, Shaheed Path(GW5). Sulphate (SO_3^{2-}) is one of the most important ions, found in the water which may cause catharsis, dehydration and gastro-intestinal irritation. Many sulphate compounds are readily soluble in water and originated naturally from the oxidation of sulphite ores, presence of shells and the solution of gypsum and anhydrite (Prakash and Somashekar, 2006).

Minimum phosphate was found 0.009 mg/l at Teeley wali Masjid (GW1) maximum was found 0.027 mg/l at Lakshman Mela Ground, Nishat Ganj (GW3). It is available in the form of phosphate in natural waters and generally occurs in low to moderate concentration. Agriculture runoff containing phosphate fertilizers as well as the wastewater containing the detergents etc. tend to increase phosphate pollution in water. (Khatoon *et al.* 2013).

Minimum nitrate nitrogen was found 0.50 mg/l at Teeley wali Masjid (GW1) maximum was found 36.96 mg/l at Lakshman Mela Ground, Nishat Ganj (GW3)..Nitrate Nitrogen was found within the range at all stations during study. Nitrate (NO_3^{2-}), is the most common pollutant found in shallow aquifers due to both point and non-point sources (Postma *et al.*, 1991). Elevated nitrate concentrations in drinking water are linked to health problems such as methemoglobinemia in infants and stomach cancer in many studies have shown that agricultural activities are the main source of elevated nitrate concentrations in ground water (Kumar *et al.*, 2015).

Conclusion:-

The study reveals that TDS, Total Hardness, Sulphate, Alkalinity and calcium and Magnesium was found higher than prescribed Indian Standard 10500-2012 while Turbidity, pH, Temperature, Conductivity, Chloride, Fluoride, Nitrate Nitrogen and Phosphate were within prescribed permissible limit. In this study it was found that GW2 station Near Shani Mandir Qaisar Bagh was safe for drinking purpose.

The average result at GW1 Station, Teeley wali Masjid shows that alkalinity was 225.67 mg/l which is higher than 200mg/l the drinking water standards(IS:10500). Rest of all the parameters were within the range as per drinking water standards (IS:10500)

Station GW3-Near Lakshman Mela Ground, Nishat Ganj showed higher Total Dissolved solids, Total Hardness and alkalinity 580.43mg/l, 291.667mg/l and 244.33mg/l respectively which were higher than the standards (IS:10500).

At GW4 station, Janeshwar Mishra Park ,Gomti Nagar, Total Dissolved solids was found 533.4 mg/l and alkalinity was observed 371.67mg/l which was higher than standard (IS:10500).

The average result at GW5-Near Sai Vitista Infratech, Shaheed Pathshows that Total Dissolved solids, Total Hardness, sulphate and alkalinity was observed 1018mg/l, 255.33mg/l,232.33mg/l and 355mg/l which are above the range as per drinking water standards (IS:10500). Rest of all the parameters was within the range as per drinking water standards (IS:10500)

The Total Dissolved Solids at most of the sampling stations were found higher than the drinking water standards (IS:10500) due to increased dissolution or evaporative enrichment. Human activities may also have affected the TDS levels in ground water i.e. application of synthetic fertilizers, manures, and wastewater percolation can all contribute salt to groundwater. High values of TDS influence the taste, hardness, and corrosive property of the water and causes excessive scaling in water pipes, heaters, boilers, and household appliances.

The hardness contributed due to seepage and run off from soil. Hardness is normally considered an aesthetic water quality factor because of the unpleasant taste that a high concentration of calcium and other ions . It reduces the ability of soap to produce lather and cause scale formation in pipes and on plumbing fixtures.

The Sulphate concentration in the ground water collected from Shaheed Path (235.7 mg/l) was higher than the drinking water standards (IS:10500) contributed due to seepage, dissolution of Sulphate minerals and run off from soil. High Sulphate values can increase the risk of diarrhoea and dehydration.

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