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Assessment of Groundwater Pollution Potential in and Around Ranipet Area, Vellore District, Tamilnadu

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----------Abstract----------
Drinking water is contaminated through the pipe distribution system or directly through groundwater due to addition of waste water discharged from domestic, industrial and agricultural sources. The present study deals with the physic-chemical characteristics of subsurface water quality in Ranipet area. Such a water samples were collected from different identified bore wells and dug wells for the purpose of studying the quality of groundwater during July 2012. The bore wells from which the samples were collected are extensively used for drinking purpose. It has been proved from the present investigation findings that value of few parameters are TDS, Total hardness, Calcium, Magnesium, Sulphate, Chloride, Fluoride and Nitrate fall out of the permissible range with reference to BIS. Drinking standards. Hence, suggested to take proper care to avoid contamination of groundwater pollution through periodic monitoring of the water quality.

Keyword: *Groundwater, Physico – chemical parameter, Heavy metals*

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I. Introduction:

Water pollution is a major problem related to the economic/industrial growth of any country. The number of industries in India, during the last decade, has grown more than ten times and accordingly the problems related to environmental degradation have increased many folds. There is a need for sustainable development of economic growth and industries. Some of the industries release their effluents either on the open land or in surrounding surface water bodies contaminating the soil, surface water and ultimately groundwater. Governments of India are aware of these problems and have started looking into the remedial measures to clean some of the highly contaminated surface water bodies. Involvement of very high costs of remediation will make this process slow and therefore, it is essential that the contamination of water bodies is controlled rather than remediation. Leather production is a major industry in India, which makes significant contribution to the country's foreign exchange earnings and provides employment opportunities to about three million people. Dissolved chromium reaches concentration levels of some g/kg^{-1} due to anthropogenic pollution from tanneries, which is generally linked to the use of Cr (VI) compounds in several industries applications such as plating, metallurgy, pigments, and leather tanning (I. Nanda Balan et al., 2012). During the process of leather manufacturing, several chemicals like Cr $(SO_4)_3$, NaCl, Ca $(OH)_2$, H_2SO_4 etc. are extensively used. Therefore, the resultant effluent is enriched with chromium and sodium salts (NaCl and SO_4). The tannery waste is characterized by its strong color (reddish dull-brown), high BOD, high pH, and high total dissolved solids (S.Srinivasa Gowd.Pradip K.Govil, 2008). Tannery effluents, being voluminous and highly puerile, when discharged untreated, damage the normal life of the receiving water bodies; and if allowed to percolate into the ground for a prolonged period, will pollute the groundwater permanently and make it unfit for drinking, irrigation, and domestic consumption. Groundwater is the main source of water supply for domestic use and drinking purpose in rural areas. It is established that a single tannery can cause the pollution of groundwater around the radius of 7–8 km (X.Rosario Arun Kumar et al., 2012). Chromium present in effluent is primarily in the less toxic trivalent form Cr (III) but when this effluent is discharged into the soil, due to varying environmental conditions, Cr (III) is oxidized to toxic hexavalent form, which seldom remains as Cr (VI) (P.N.Palanisamy et al., 2007, I. Nanda Balan et al., 2012). The relation between pollution and health problems is now well documented and reasonably well known by the general public (Charmaine Jerome and Anitha Plus, 2011). In Tamilnadu state, where more than 60% of India's economically important tanning industry is located, tannery waste containing chromium and sodium compounds has, over many years, contaminated 55,000 ha of agricultural land. Thousands of farmers lost their farms, or part of their earning capacity because of this contamination. Incidence of respiratory diseases among workers exposed to occupational and environmental risks of tannery industry at Ranipet industrial area is reported (A.Moharir et al., 2002). In many areas of Tamil Nadu, groundwater is not suitable for domestic use, forcing villagers to travel 4–5 km for water. Much of the groundwater is unsuitable for irrigation, and hundreds of wells in the region can no longer be used

(H.Manjunatha et al., 2011; I. Nanda Balan et al., 2012; J. Maheswari and K. Sankar, 2011). This is also one of the contaminated sites identified by Central pollution control board, India. The primary objective of the present study was to assess the heavy metal contamination and their distribution in groundwater.

II. Materials And Methods:

Study Area:

In the study area bounded between Latitude N 12°52′30'' – 12°57′30'' and Longitude E 79°15'00''– 79°25′00'' is located in North of TamilNadu in India (Fig 1). The area is enclosed in toposheet No.57 P/5 SE – SW of Survey of India. The study are extends over an area of 154.52 Sq.Km. The drainage of the study area is mainly Palar River and Ponnai River. It includes Ranipet, Walajapet, Arcot and Melvishram. The Ranipet area is a chronic polluted area and one of the biggest exporting centers of tanned leather. Many small-scale tanneries are processing leather in the study area and discharging their effluents on the open land and surrounding water bodies (S.Srinivasa Gowd.Pradip K.Govil, 2008). The total numbers of tannery industrial units located in and around this town are 240 besides other industries like ceramic, refractory, boiler auxiliaries plant, and chromium chemicals. Industries located in Ranipet are discharging effluents into Puliathengal, Vanapadi, and Thandalam lakes and it is a matter of increasing concern, as these industries are located in Palar river basin. Studies of groundwater also indicated the high concentrations of chromium in Palar river basin, which is much more than the permissible limit in drinking water. These tanneries are polluting the Palar River, causing ecological degradation and health hazards (Maheswari. J. and K. Sankar, 2011). Geologically the study area is covered by crystalline rocks of Archaean age consisting of Granites and some basic intrusive bodies. The alluvium consisting of fine to coarse sand and clay occurring in the area is of a fluviatile origin and restricted to the course of Palar river and major streams (Gautam. D.K. and M.R. Sharma, 2011).

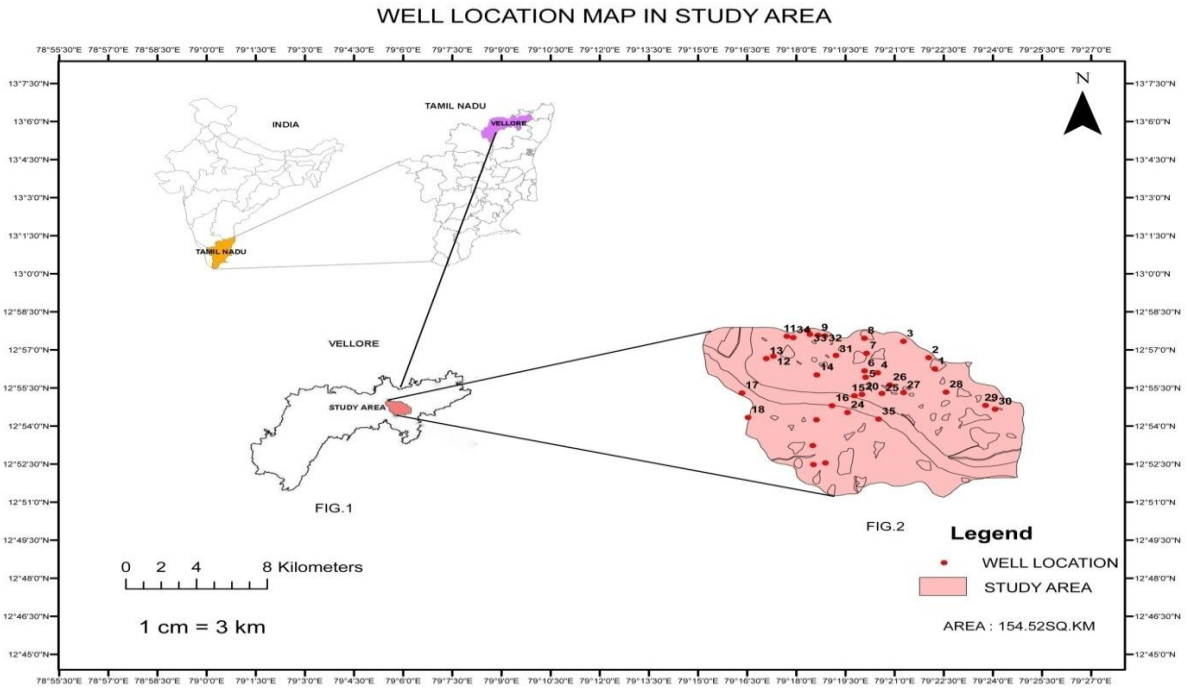

Fig. 1: Location of the Study area
Fig. 2: Location of the well sampling stations

III. Methodology:

Sample Collection And Processing:

Standard method of collection, preservation and analysis were adopted (APHA, 2002). The sampling was done from different stations Fig 2. For the assessment of groundwater quality, 35 water samples were collected from bore wells and open wells in the study area during July 2012 and were analyzes for the major physico – chemical parameters (Table 1). The physical parameters such as pH, Turbidity, Electrical conductivity, TDS were determined, the chemical characteristics including heavy metals for examination of water (APHA, 2002). The results obtained were evaluated in accordance with the standards prescribed under 'Indian standard drinking water specification IS 10500: 1992' of Bureau of Indian Standards.

RESULT AND DISCUSSION:

The present study areas of the turbidity of sample stations are within the permissible limit (10 NTU). High concentration of dissolved solids about 3000 mg/l may also produce distress in livestock. The values of EC ranged from 516 and 6046 (ds m -1). The pH value varied between 7 and 7.4 (Table 1). All the samples were within the permissible limits of IS: 10500 standards for drinking water. The values of alkalinity at stations were found in the range of 108 – 472 mg/l. Total hardness values ranged from 212 to 1299 mg/l values of all type of hardness were quiet high with their prescribed standards. The well stations No. 3, 4, 17, 26, 29 is within the permissible limits (Table 1). The higher value is mainly found owing to abundant availability of limestone rocks in the surrounding area consequently more solubility of Ca++ and Mg++ salts under anaerobic conditions (P.N.Palanisamy et al ., 2007).

Calcium hardness values ranged from 48 to 320 mg/l. The maximum permissible limit of calcium hardness is 75 mg/l. The well station No. 3,4,5,11,13,17,21,26,29,32,33 is within the permissible limits. Melvishram (320 mg/l) and Arcot Bus stand (216 mg/l) of well stations No. 17 and 24 are extend the permissible limit of 200 mg/l (Fig 3). Calcium is a major constituent of various types of rock. Calcium is a cause for hardness in water and incrustation in boilers. Magnesium hardness values ranged from 22 to 96 mg/l (Fig 3).

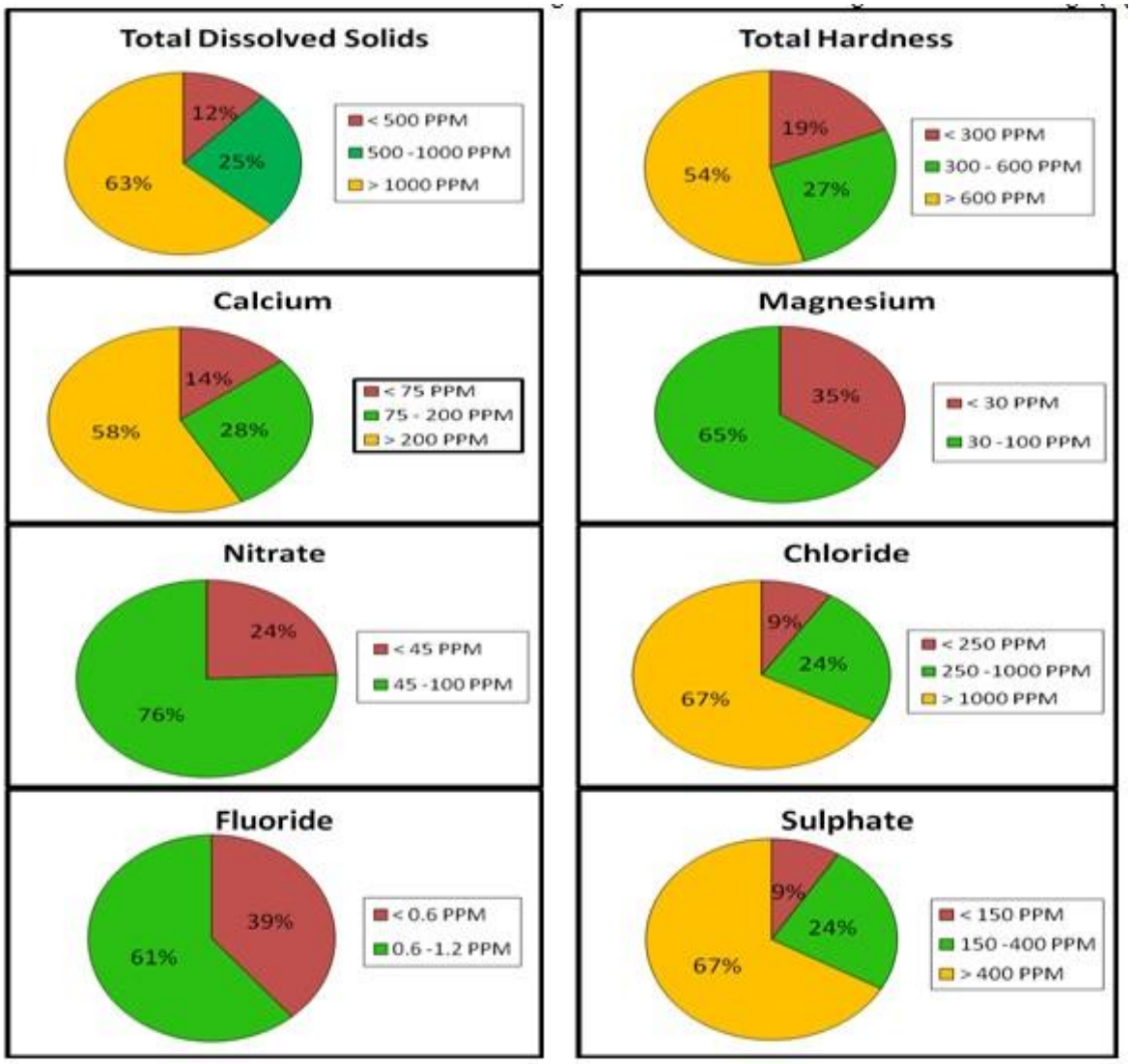

Fig 3 : Variation of Physico – chemical characteristics of groundwater sources

Table 1 : Physico - Chemical Analyses of Groundwater Samples of the study Area

Well No	Well Type	Village	Turbidity NTU	TDS mg/l	EC, micromhos	pH	Total Alkalinity	TH mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Iron mg/l	Free Ammonia mg/l	Nitrite mg/l	Nitrate mg/l	Cl mg/l	F mg/l	So_4 mg/l	Phosphate mg/l	Chromium PPM
1	DW	Anantha lai	4.6	1386	1980	7.21	112	340	76	36	282	18	0.29	0.03	0.1	17	490	0.56	240	0.03	0.0008
2	BW	Pudhu Pettai	2.4	1932	2762	7.29	188	580	128	62	350	20	0.21	0.03	0.01	33	723	0.73	320	0.09	0.002
3	BW	Ammur	3.3	362	516	7.28	144	212	48	22	28	4	0.32	0.07	0	20	42	0.82	29	0.04	0
4	BW	Maanthangl	5.2	1250	1786	7.06	108	280	64	29	252	12	0.18	0.12	0.33	8	445	0.48	213	0.13	0.001
5	BW	Navalpur	1.9	1562	2232	7.14	296	330	72	36	280	14	0.11	0.04	0.29	46	381	0.61	126	0.06	0.002
6	BW	Thandalam	1.8	3922	5602	7.32	396	820	200	77	790	50	0.26	0.02	0.43	18	1415	0.86	356	0.12	0
7	BW	Settithangal	2.6	3118	4454	7.29	412	760	168	82	660	40	0.31	0.03	0.14	22	1010	0.79	294	0.11	0.0008
8	DW	Vanapadi	3.1	2796	3992	7.18	440	720	196	55	550	30	0.26	0.03	0.07	33	528	0.68	246	0.06	0.001
9	BW	Ranipet Agravaram	0.8	2908	4156	7.24	456	740	200	58	590	30	0.19	0.92	0	11	540	0.69	224	0.07	0
10	BW	Sipcot - I	0.6	1466	2094	7.19	356	340	80	34	280	20	0.16	1.09	0.2	11	302	0.71	176	0.03	0.0004
11	BW	Pulianthangal	1.9	1206	1722	7.23	284	330	72	29	250	18	0.32	1.57	0	7	262	0.39	158	0.02	0.002
12	BW	Maniyampattu -1	0.8	1566	2236	7.28	244	350	76	38	352	30	0.14	1.15	1.11	9	376	0.48	182	0.06	0.0008
13	BW	Thengal	1.8	1390	1984	7.31	316	320	72	34	280	20	0.21	1.18	1.38	44	247	0.43	149	0.07	0.001
14	BW	Puliamkannu	2.6	1400	2012	7.26	112	350	76	38	280	20	0.26	4.29	0.06	70	426	0.34	182	0.2	0.0008
15	BW	Palar River	3.2	2666	3808	7.11	440	710	192	55	540	30	0.29	6.18	2.09	31	624	0.41	382	0.34	0.002
16	BW	Veppur	2.6	4232	6046	7.28	312	1200	320	96	760	50	0.39	0.15	0.46	27	1609	0.73	452	0.04	0
17	BW	Melvisharam	0.9	886	1264	7.19	296	256	56	28	160	12	0.18	0.15	0.02	37	148	0.62	93	0.07	0.004
18	BW	Kathiavadi	3.1	2006	2862	7.04	268	610	168	48	368	24	0.22	0.14	0.06	69	594	0.59	286	0.23	0.001
19	BW	Masappettai	4.2	3196	4564	7.02	392	820	200	77	660	40	0.29	0.06	0.08	38	940	0.42	486	0.06	0.0008
20	BW	Arcot Main - Town	5.3	2336	3336	7.29	216	660	168	58	460	30	0.31	0.08	1.38	70	802	0.29	340	0.008	0
21	BW	Uppupettai	5.2	1262	1802	7.16	292	320	72	34	260	16	0.41	0.15	0	22	287	0.62	168	0.12	0.0008
22	DW	Krishnavaram	3.6	2088	2982	7.29	212	620	168	48	360	30	0.3	0.05	0	8	728	0.64	352	0.1	0.0004
23	BW	Kurampadi	4.2	1772	2532	7.31	392	520	132	46	340	20	0.36	0.05	0.08	29	396	0.58	224	0.04	0.0004
24	BW	Arcot Bus Stand	8.6	3056	4364	7.39	472	730	216	48	640	40	0.46	0.45	0.25	67	891	0.71	238	1.29	0.0008

25	BW	V.C.Mottur -1	3.1	1422	2032	7.09	240	350	76	28	320	30	0.29	0.23	0	35	376	0.63	192	0.41	0.001
26	BW	V.C.Mottur - 2	4.6	1138	1626	7.12	212	270	56	31	250	20	0.42	0.3	0.22	3	295	0.49	182	0.1	0.0008
27	BW	Vanniyavedu	2.9	1788	2556	7.2	392	400	88	43	360	40	0.31	0.07	2.57	46	396	0.56	189	0.02	0.0008
28	BW	Walajapettai	3.2	1096	1564	7.19	208	386	84	42	182	12	0.34	0.22	2.05	60	247	0.45	124	0	0.002
29	BW	Chennasamudaram	0.9	636	906	7.01	108	260	56	29	94	8	0.16	0.07	0	15	158	0.38	92	0.03	0.001
30	BW	Pulithangal	1.8	1674	2392	7.23	356	410	88	46	360	40	0.22	0.43	0.2	46	391	0.48	196	0.4	0.0008
31	BW	Ranipet Sipcot - II	2.8	1076	1536	7.28	188	360	76	41	180	20	0.19	0.07	0	3	282	0.38	130	0.11	0.001
32	BW	Ranipet Sipcot - III	1.6	1089	1556	7.19	192	350	72	41	186	22	0.1	0.12	0	3	322	0.39	136	0.03	0.0008
33	BW	Ranipet Sipcot - IV	3.4	1062	1518	7.22	196	340	72	38	178	18	0.14	0.02	0.02	2	292	0.38	129	0.04	0.0004
34	BW	Maniyampattu - 2	4.2	2328	3324	7.19	440	640	160	58	460	50	0.13	0.09	0.09	60	559	0.45	244	0.01	0.0008
35	BW	Mudiyor Illam	5.5	1290	1842	7.16	344	390	80	46	220	18	0.22	0.14	0.14	10	238	0.39	152	0.02	0.001

maximum permissible limit of calcium hardness is 30 mg/l. The well station No. 3, 4, 17, 25, 29 is within the permissible limits. Chemical softening, reverse osmosis, electro dialysis, or ion exchange reduces the magnesium and associated hardness to acceptable levels. The concentrations of sodium in the study are ranges between 28 to 790 mg/l in all the samples (Table 1). Person afflicted with certain diseases requires low sodium concentration.Potassium ranks seventh among the elements in order of abundance yet its concentration in most drinking waters seldom reaches 20 mg/l. However, the concentrations of potassium were analyzed from 4 to 50 mg/l for all the samples. Iron content from sample stations is found to be in the range of 0.1 – 0.46 mg/l (Table 1). The well station No. 3, 7, 11, 16, 20, 21, 23, 24, 26, 27, 28 is more than the permissible limits. High levels of iron are attributed to the dominating literatic soil. The nitrite concentration in the study area of ground water in the range of 0 to 2.09 mg/l. The normally permissible limit of nitrite is 0 – 0.1 mg/l. In the palar river (well station No. 14) is highly nitrite concentration (2.09 mg/l) in the water (Table 1). The nitrite concentration in groundwater in normally low but can reach high levels as a result of leaching or runoff from agricultural land and contamination from human or animal wastes as consequence of the oxidation of ammonia and similar sources. Anaerobic conditions may result in the formation and persistence of nitrite. The nitrate concentration in the study area ranges from 7 – 70 mg/l. The permissible limit of nitrate is 45 mg/l. The well station No. 5, 14, 18, 20, 24, 27, 28, 30, 34 are more than the permissible limits (Fig3). Nitrates generally occur in trace quantities in surface waters but may attain high levels in some ground waters. It can be toxic to certain aquatic organisms even at concentration of 100 mg/l. In excessive limits, it contributes to the illness known as methenoglobinemia in infants. The Chloride concentration in the study area ranges from 42 – 1609 mg/l. The permissible limit of chloride is 250 mg/l. The well station No. 3,13,17,29 is within the permissible limits. But the well station No. 6, 7, 16 are extend the limit of above 1000 mg/l (Fig 3). High chloride content may harm metallic pipes and structures as well as growing plants. Chlorides in excess imparts the salty taste to water and people are not accustomed to high chloride are subjected to laxative effect (H.Manjunatha et al., 2011).

The fluoride concentrations were found to be in the range of 0.26 to 0.86 mg/l. In groundwater, fluoride concentrations vary with the type of rock that the water flows through but do not usually exceed 10 mg/l (V. Ashwini et al., 2010). Presence of large amounts of fluoride is associated with dental and skeletal fluorosis (1.5 mg/l) and inadequate amounts with dental caries (< 1 mg/l). The sulphate concentrations were found to be in the range of 29 to 486 mg/l. The well stations No. 3, 6, 13, 17, 28, 29, 31, 32, 33 is within the permissible limit (Table 1). The major physiological effects resulting from the ingestion of large quantities of sulfate are catharsis, dehydration, and gastrointestinal irritation. Sulfate may also contribute to the corrosion of distribution systems.The levels of phosphate in groundwater from all parts of the sample stations are found to be in the range of 0.1 – 1.29 mg/l(Table 1). High concentration of phosphate might be due to use of detergents for washing of clothes and utensil activities by the villagers around most of the dug wells. The chromium concentration in the

study area ranges from 0-0.008 mg/l (Table 1). Tannery effluents are mostly characterized by high salinity, high organic loading, and specific pollutants, such as chromium (M.Ibrahim Bathusha et al., 2006).

Conclusion:

Groundwater quality in and around Ranipet area shows high mineral contents in terms of total dissolved solids, total hardness, calcium, magnesium, nitrate, chloride, fluoride, iron and sulphate and rated as 'poor to very poor'. The reason for higher values of physico-chemical parameters at certain sampling locations may be due the unsciencitific disposal of solid wastes, the depth of the wells and nature of the geological materials with which the groundwater comes in contact may influence the quality of the water. So from this research study, it can be concluded that groundwater of the study area in some locations are not suitable for drinking purposes.

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