International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.9, pp 808-816, 2017

Assessment the quality of water wells in the artesian of Laylan

Ahmed M.H.AL-juboori*, Muafak.E.Salih

Department of Biology, College of Education for Pure Sciences, University of Tikrit, Iraq

Abstract : The study was conducted to evaluate the quality of 6 wells in Laylan area and its related areas. The temperature of water, air, electrical conductivity , total number of bacteria, coli forms and fecal coli forms were evaluated in Laylan, Yihyawa, Haji Metab, Tuba Lu and the village of Badawa, The samples were collected from November 2016 until June 2017 by one sample per month for each site. The result of the study were for most factors within the permissible limit for drinking water and ranged from 0.00 to 0.99 naphthalene. The temperature of the air values ranged from 9 to 41 m and water temperature ranged from 21 to 24 m, and the values of electrical conductivity ranged between (444-1630) microsments /cm . The total number of air bacteria ranged from (60-230) cells /ml, and the values of total colon and coli form values were lower cell/100ml.
Key words : Assessment , Well water in the artesian , quality , water , Laylan area.

Introduction

Water is the most important compounds in the organisms live because its contained in compounds of organisms at high rate .Whereas, the water in organism's bodies is amount 60 to 70% from bodyweight for animals but the water in micro-organisms is amount 90% from organisms weight [1].

Groundwater is an important recourse for waters in several industrial, agricultural and domestic areas. Whereas, many countries rely on groundwater and that because it is always available but river water is shortage like countries of the Middle East and north African which predominantly desert and dry , and the needs of water increasing with an increasing population and agricultural areas [2]. The study of water well quality is important in the currently time and that for high needs to clear water and devoid from biological and physical pollutants and most importantly aerobic bacteria like coli forms and fecal coli forms which are clear indication on the validity of water from the bacteria , and the physical properties that effective on water it is turbidity and electrical junction which entrance too in determining the water quality for different uses. Routine use of water and the pollution that progress in this area's leading to water shortage . Whereas, many researchers and organizations resort to find clear groundwater and devoid of pollution and to be serviceable [3] the aim of this study is to assessment the quality of water wells and to know how validity of drinking water and other uses in this area.

The place of take a sample

Six well was selected for this study, that located in Laylan and followed area that located within Kirkuk Governorate , it was by following sequence:

Water Well 1 Laylan Area Center

This well located in Laylan area inside the irrigation project that feeds most areas.

Water Well 2 YihyawaVillage

This village located next to Laylan which is considered this well from the wells that feeds the area with water because its existence in village project.

Water Well 3 Haji MetabArea

It located in Haji Metab and feeds near houses and some trees in the area.

Water Well 4 YarmjaVillage

It located in Yarmja Village within Asala Village project and feeds most houses by clean water.

Water Well 5 Tuba Lu Area

This well is in Tuba Lu Area and it feedsneighboring houses .In addition to, camp of internally displaced persons that nears on it.

Water Well 6 BadawaVillage

It located in Badawa Village within Asala Village project and it feeds the houses in village by clean water.

Materials and methods of work

Turbidity: the turbidity was measured by Turbidity meter , type HANNA-LP2000 after access to laboratory directly which measured by (NTU) whereas the sample was shake to be sure that it melted and filled with cell until measuring the indicator and fingerprint was cleared from cell by piece of cloth.

Temperature: the temperature was measured by agricultural field for air and water by using mercury thermometer within the range (100-0)M.

Electric Conduction: the viability of electric conduction was measured by multi parameter analyzer from type CONSORTC 830 after recalibrated the machine and it was measured by (Micro-siemens).

The total number of bacteria: to examine the total number of bacteria we operating light chain by shake water sample many times and takes 1 ml from water sample and adding it in large test tubes contain (9) ml from aqua destillatasteriles to get concentration 10^{-1} then we take (1)ml from the first and adding (9) ml from aqua destillatasteriles so the concentration becoming 10^{-2} .Thus we continue in reducing [4] then take (1) ml from each reduce And it is poured into sterilized petri dishes (2 replicators) and then the Culture Medium (Nutrient Agar) is poured when it reaches about 50 ° C and then the dish is moved in a circular movement to ensure the mixing of the sample and the medium well, and then the dishesare incubated at about (37) ° C for (18-24) hours, and the total number of bacteria is calculated [5]. Then the total number of air bacteria in (1) ml is calculated by multiplying the number of colonies by theinverted dilution [6] .

Total number of coliform bacteria: The total number of colon bacteria was calculated by the method of most probable number (MPN) and the confirmatory and complementary tests.

Total number of fecal coliform bacteria: The same method used to calculate the total number of coliform bacteria was followed.

Results and discussion

Temperature

Temperature plays an important role in all metabolic processes and interactions in organism's bodies. These processes are directly proportional to temperature because they increase the kinetic energy of ions,

molecules and atoms [7]. The current study of air temperature recorded rates ranging from (21-21.50) in wells 6,5,3,1 and 2, respectively, where the highest value of air temperature was 41 in the well No. 4 in the month of June of the study and the lowest value was 9 in well No. 1 of the month of January. The study showed that there are clear differences in air temperature. This may be due to the differences in the location of the wells with time difference of taking each sample, where the temperature is low at sunrise and then gradually increases and also because the climate of Iraq is characterized by different temperature from one season to another and this is the probable cause of temperature differences for the areas surrounding the wells [8].

The results of the study, as shown in Table (1), recorded rates ranging from (21-21.50) ° C in most wells and well 2 , respectively, where the highest value was 41 ° C in the well 4 in June, whereas the lowest value was 9 ° C in the well 1 in January, and the results were less than the results obtained by [9] in his study of groundwater in the north of Saladin, which ranged between (0-44) ° C. Similar results are obtained by [9] in his study of the quality of groundwater in the district of Tuz and its areas , it was found that the temperature of the air ranging between (8 – 35) ° C. The results showed that there is a difference in temperature. This may be due to the nature of climate ,where it is cold in the winter and hot and dry in the summer and to the difference between daytime and night-time temperatures, as well as to the difference in times of taking the samples , the results of the statistical analysis of Duncan 's analysis of variance at a significance level ($p \leq 0.05$) showed that there were no significant spatial differences but there were significant temporal differences.

They were divided into groups according to the months of study and the temperature of the lowest group is January and the highest group is June and the other groups were among them.

Table No. (1) Monthly and location changes in air temperature of the wells of study (° C)

Wells / Date	1	2	3	4	5	6
11/2016	18	17	17	16	18	17
12/2016	13	15	14	12	13	13
1/2017	9	10	10	11	10	10
2/2017	15	15	16	17	14	15
3/2017	20	21	21	22	20	21
4/2017	21	22	23	22	23	22
5/2017	32	33	29	30	32	31
6/2017	40	39	38	41	38	39
Average	21.00	21.50	21.00	21.37	21.00	21.00

One of the characteristic of water temperature is that it has a limited change unlike the air temperature [10] . This was proven in the current study, where it was found that the temperature of water has a slight change during the study period unlike to what was found in air temperature . The results of this study were shown averages in Table (2), that ranging between (22.25-24.12) ° C in the well No. 5 and 1, respectively, where the lowest temperature of 21 was recorded in the well No. 5 and in December and May and the highest value was 25 in the well No. 1 and in December and January and April .The reason for the high temperature in the well No. 1 may be due to the depth of the well and the way it was constructed in a closed manner. The results of the study were similar to the results of the study obtained by [11] in her study of the quality of groundwater as one of the aquatic ecosystems of the city of Kirkuk , where the temperature values ranging between (19.8-24.6) for the month of January and July respectively. The reason of the slight change in temperature may have caused by the distance of water from the atmospheric changes and also the preservation of the earth's core on the stable heat of water. The results of the statistical analysis revealed that there were significant temporal and spatial differences between the wells of study at a significance level of ($p \leq 0.05$) and they were divided into three groups according to the location of the first geographical wells, which are the lowest and it includes (6>5) and the second is the highest and it includes (1) and the third is (2>3>4) . They also can also be divided by months and temperature to three groups include : (the lowest) that includes (May) and the second group (the highest) and includes (April) and the other group is among them. The results of the study were in conformity with the

standard specifications [12] .And the international standards [13,14] , that range between (15-35) degrees Celsius.

Table No. (2) Monthly and location changes in the temperature of groundwater during the study period (° C)

Wells / Date	1	2	3	4	5	6
11/2016	23	22	24	22	23	23
12/2016	25	24	22	23	21	23
1/2017	25	23	24	24	22	22
2/2017	24	23	23	24	24	22
3/2017	24	24	22	22	23	22
4/2017	25	24	23	23	22	23
5/2017	23	23	22	22	21	23
6/2017	24	24	23	22	22	23
Average	24.12	23.37	22.87	22.75	22.25	22.37

Turbidity

Turbidity is a measure of scattered light through the suspended particles and the molecules in the water column and it does not spread in a straight and the turbidity depends on the amount of suspended materials and their size [8].The groundwater is characterized by its low turbidity compared to surface water where it is filtered through soil layers and it is relatively slow or possibly static, which is free of nutrients, thus reducing the number of bacteria and other organisms that cause turbidity [15] . In this study, rates ranging from (0.06- 0.26) were recorded in the well 6 and the well 3 , respectively , as shown in Table (3). The highest recorded value during the study period was 0.99 NTU in the well No. 3 and the lowest recorded value was 0 .00 in most wells of study and in different months. The results were less than the results obtained by [16] in her environmental and diagnostic study of the groundwater in selected areas of Saladin , where the values of turbidity ranged from (0.00-24.15) NTU ,and also less than the results obtained by [11] in her study of bacterial markers of biological contamination and their relationship with the physical and chemical factors of the environmental systems in Kirkuk (0.84-6.67) NTU.These results came close to the results obtained by [17]in his environmental study about the quality of groundwater in the district of Tuz and its villages where the values ranged between (0.00-29.88) NTU.

Maybe the reason of decline the values of turbidity in the study area that the groundwater is static and little affected by external factors .In addition to, adept of wells and the way of drilling and packaging. Therefore, be very difficult a leakage for the wells through the rainwater and others , the results of statistical analyses were found that Pearson Correlation Coefficient has negative relation with iron (r=299) at a significant level($P \leq 0.05$), and through the contrast of analysis test found absence of spatial significant differences but there are temporal significant differences at significant level ($P \leq 0.05$) where the wells was divided to two groups according to months of study ,first group and it is (lowest) includes the month of (June> May> February> January>April> November) and the second group (highest) includes the months (December> March) , where they were adapted all the studying of wells Iraq's drinking water(Cosqc ,1996) and Global Drinking Water [13,14,18] and which estimated at about NTU 10 > .

Table No. (3) monthly and location changes for turbidity in the groundwater during period of study (naphthalene turbidity unit)

Date / Wells	1	2	3	4	5	6
11/2016	0.00	0.81	0.00	0.32	0.00	0.11
12/2016	0.61	0.53	0.42	0.00	0.51	0.22
1/2017	0.00	0.20	0.30	0.10	0.00	0.00
2/2017	0.00	0.00	0.00	0.03	0.00	0.14
3/2017	0.90	0.00	0.35	0.61	0.52	0.00
4/2017	0.04	0.09	0.99	0.00	0.00	0.00
5/2017	0.00	0.00	0.00	0.02	0.00	0.04
6/2017	0.03	0.00	0.04	0.02	0.00	0.00
Average	0.19	0.20	0.26	0.13	0.12	0.06

Electric conduction

Electric conduction is the ability of water to deliver electricity supply through the water and it depend to concentrate and Ion equivalence in the water and temperature . Given the fact that Ions are responsible for the electricity transmission next there's direct connection with the salt and dissolved substances in the water [8] . the study recorded as in table (4)

Electric conduction rates and which ranged (158-475.38) micro siemens /cm in the wells 2 and 6 respectively , and it was the highest value for the connectivity is 1630 in the well No.6 in the month of May and the lowest value recorded 444 in the well 2 of the month of April , and this results is come less than he got it [19] in his studying for the groundwater in Samarra district and which ranged it connectivity values (6690-1880) micro siemens / cm . and approach to results [20]in their studies for quality assessment the groundwater in the Bartalla and Shikhan area Northern Iraq and which recorded it Connection values ranged it between (1602-462) and less results he got it [17] in his environmental studies about groundwater quality in Tuz district and throw following it and which ranged it the connectivity values between (6890-774) micro siemens/cm . Might come back the cause of variance in the connectivity values to the natural geological to the ground where the water quality is depend on the type and nature of the rocks and the soils and on the Period of contact between them and which Lead to dissolution of materials through the Contact (Hem ,1970) . and connectivity increases by processes farmalands watering operations which is shovel the salts and the ions with it therefor increase the connection amount in the farming areas [21] . Maybe the reason of declines electrical conductivity values to existence of Sherin Dam northwest Studying area and also existence of Lake Balkana North studying area which is considered the most important reservoirs for storage of rainwater in this area through this water works on groundwater relief maybe one of the reason for the decline electrical conductivity values .

Table No. (4) monthly and location changes for the electrical connection for the groundwater during the period of study (micro Siemens/cm) .

Wells / Date	1	2	3	4	5	6
11/2016	533	445	752	1233	483	1556
12/2016	530	450	744	1193	511	1546
1/2017	573	447	712	1181	536	1550
2/2017	548	540	720	1156	551	1557
3/2017	556	462	741	1170	588	1610
4/2017	542	444	712	1201	650	1590
5/2017	580	499	810	1253	499	1630
6/2017	601	516	803	1240	595	1599
Average	557.88	475.38	749.25	1204.25	540.38	1581.00

Pearson Correlation Coefficient found that there is positive relationship with all of dissolved solid materials and total hardness and Calcium, magnesium, Chloride, Sulfate, Potassium and Zinc hardness respectively at level (p<=0.01)(0.416,0.598.0.666.0.868.0.876,0.845.0.884,0.907) and negative correlation with dissolved oxygen (0.322) at significance level (p<= 0.05), the results of variance analysis showed that there are significant spatial difference and significant temporal difference at significance level (p<= 0.05) between study's wells. And this results conformity with Iraq drinking water standard [12] and global drinking water [13,14,18] and its amount 1600 Micro-Siemens /cm.

The total number of bacteria

The total number of bacteria is important indicator to know the quality of water ,the appropriateness of the human use and determining the purity degree, and natural water contains many types of aerobic and anaerobic bacteria , autotrophs and heterotrophs , and its preparation depends on sources of water pollution , whenever the water was polluted , the preparation of bacteria increasing , in this test there is no exacts number given for bacteria because of their ability of division in any time and for diagnostic difficulties of all bacteria types and there was no central agriculture for grow all types, Nutrient Agar that many types of autotrophs bacteria grow on it was used [22]. The bacterial cell can division in its place and create invisible settlement by counting the number of settlement that means counting the number of bacterial cells in water sample [23]. The results of current study , Table (5) for the total number of bacteria have been recorded averages between (141.88-115.63) cell/ ml in two wells 1 and 4 respectively, and the highest recorded value for the total number of bacteria was 250 cell/ml in well 2 and in December, but the lowest value was 60 cell/ ml in the quality of ground water south Salah Al-din and the averages ranging ($^{2}10*72$-48.4) cell /100 ml, and approach for his reach [24] in study for somebiological, physical and chemical features for some Tikrit wells that reaches the total number of bacteria (1188-37)*10^{1} cell / ml , and relatively less than the results that obtained by [25] in his study for some Tikrit wells quality and the averages for the total number of bacteria between(1317.5-301.8) cell/ml , the lowest number for bacteria during the study period due to that the wells were classified from very deep and closed whereas it inaccessible for pollution because it is padded from inside and far fromagricultural and industrial pollution sources, Pearson Correlation Coefficient recorded negative relation with each of air temperature , nitrate and iron according to follow values (0.422,0.416,0.381) at significance level (p<= 0.01) .

Table No.(5) Monthly and Location Changes of the total numbers of bacteria in groundwater during the period of study (Cell/ml)

Wells / Date	1	2	3	4	5	6
11/2016	120	160	140	180	220	200
12/2016	100	90	170	190	210	150
1/2017	140	250	80	120	130	180
2/2017	65	155	110	200	95	160
3/2017	205	195	230	85	90	70
4/2017	140	70	130	80	100	90
5/2017	80	95	105	120	135	140
6/2017	75	60	100	160	80	105
Average	115.63	134.38	133.13	141.88	132.50	136.88

The Results of statistical analysis for analysis of variance test showed that there were significant temporal differences and there were no significant spatial differences at a significance level ($p \leq 0.05$), they can be divided by study months and numbers of bacteria into two groups. The first group is (the highest) AND IT includes a month of (November) and the second group is (the lowest) and it includes months (June ,April ,May ,February ,March ,January and December). The results of the current study were in conformity with the standard specification for Iraqi drinking water [12] and the specification of global drinking water [13,14,18] which is about 50 cells / 100 ml.

Total number of coliform bacteria

The existence of coliform bacteria in natural water is considered as a water pollution of pathogenic bacteria which their source is human , animal , soil or residues of the decomposed plant [26].

Some kind of coliform bacteria is Escherichia coli that is considered as a member of the intestinal family *(Entrerobacteriaceae)*and the proportion of these bacteria in the intestines of humans and animals is about 10% . Coliform bacteria is bacillary aerobe optional and gram-negative and it does not form the sporulation. The Lactose fermentation at temperature 35 during 48 hours [27].These bacteria are abundant in water and they have a longer period of stay and they are easy to detect , so it is considered as an indicator of the existence of pollution in water. The results of the current study recorded Low rates of colonic bacteria in Table (6) that did not exceed <3 cells\100 ml in all wells of study. These results were close to the results obtained by [24] which the rates of coliform bacteria ranged between (817.5-<3) cell / 100 ml where their rates in the wells (2,3,4,5,6) were <3 cells /100 ml during the study period , and also less than the results obtained by [9] which the rates of coliform bacteria ranged between (2140-<3) cell / 100 ml , and they are close to the results obtained by[25] in his study of some wells in Kirkuk that the total rates of coliform bacteria ranged between (20_0) cells /100 ml . They are also identical with the results of [28] in her study for the assessment of ground water in Qarqosh, north of Mosul . The results of the study in all wells were free of bacteria except the well No. 1 that it showed a positive result . Similar results are obtained by [29] in her study of the quality of groundwater in Hilla that recorded the highest value which reaches 90 cells \ 100 ml in the well 12 during the period of study and less than <3 in all wells of study. The low values of total coliform bacteria may be caused by the fact that these wells are completely closed and lined from the inside and they were classified as deep wells, whenever the deeper the well is , the fewer the number of bacteria is , due to the difficulty of arrival the waste of animal, human and plants to the deep water also the difficulty of enter air containing bacteria and other pollutions into the wells and they are far from sources of industrial pollution and agricultural waste. The results of statistical analysis of variance analysis showed that there were no significant temporal and spatial differences .The results of the current study were in conformity with the standard specification for Iraqi drinking water [12] and the specification of global drinking water [13,14,18] which ranged between 1-2 cells/ 100 ml.

Table No. (6) Monthly and location changes of coliform bacteria 's total number in ground water during the period of study (cell/100 ml)

Wells / Date	1	2	3	4	5	6
11/2016	<3	<3	<3	<3	<3	<3
12/2016	<3	<3	<3	<3	<3	<3
1/2017	<3	<3	<3	<3	<3	<3
2/2017	<3	<3	<3	<3	<3	<3
3/2017	<3	<3	<3	<3	<3	<3
4/2017	<3	<3	<3	<3	<3	<3
5/2017	<3	<3	<3	<3	<3	<3
6/2017	<3	<3	<3	<3	<3	<3
Average	<3	<3	<3	<3	<3	<3

Total number of fecal coliform bacteria

The existence of fecal coli form group is a clear indication of water pollution from human, animal and birds waste the disclosure about it is considered as A Guide to Recent Water Pollution by sewage water included Escherichia coli and this is an evidence about the existence of Pathogenic bacteria in the water [30] Colon bacteria is the bacteria that tolerate temperature up to 44 from growth , gas production and fermentation of Lactose Sugar [18] . The results of study recorded table (7) that rates is lower than <3 cell\100 ml in all wells study. and these results were lower than [24] results which ranged the rates of Fecal coli form bacteria (679.4-<3) cell\100 ml . While the wells results of the current study (6,5,4,3,2) fitted in the number of fecal coli form

bacteria ,and lower than the results of [11] where it recorded its highest rate 2.15 x 10 cell \ 100 ml and the lowest rate 0.2 x 10 cell \ 100 ml, and relatively approachable to results of [25] in his study about quality of Kirkuk which reached rates of fecal coli form bacteria between (20.8 - 0.00) cell \ 100 ml , the number of fecal coli form bacteria was very low the reason might due to these wells are closed nozzle , their depths more than 100 meters and there are far from Sewage sources ,water factories and agricultural waste.

Table No. (7) Monthly and Location Changes of the total number of Fecal Coliform bacteria's in groundwater during the period of study (cell \ 100 ml)

Wells / Date	1	2	3	4	5	6
11/2016	<3	<3	<3	<3	<3	<3
12/2016	<3	<3	<3	<3	<3	<3
1/2017	<3	<3	<3	<3	<3	<3
2/2017	<3	<3	<3	<3	<3	<3
3/2017	<3	<3	<3	<3	<3	<3
4/2017	<3	<3	<3	<3	<3	<3
5/2017	<3	<3	<3	<3	<3	<3
6/2017	<3	<3	<3	<3	<3	<3
Average	<3	<3	<3	<3	<3	<3

Results of statistical analysis of variance analysis showed there are no temporal ,spatial and significance differences.

the results of the study fitted of Standard Specification for Iraqi Drinking Water [12] and Specification of global drinking water [13,14,18] which ranged rates between 1-2 cell \ 100 ml .

References

1. Amer, A. A and Sulaiman, M. M. (2003).Environmental pollution. The problem of time ,Publication house. Egypt .
2. Al-Janabi, M. A. (2007) Hydrochemistry of open aquifer and the relation of its water to the Reservoir Sediments in the Basin of Tikrit- Samra'a (East of Tigris). PhD thesis. College of Science: University of Baghdad.
3. Osunbitan, J.A.; Okunade, D.A. and Fapohunda, H.O. (2005). Evaluating the quantity and quality of ground water for irrigation in the Basement . Nigeria. J . Environ. Hydrol.13 : 12.
4. APHA (American Public Health Association). (1998) . Standard method for the examination of water and wastewater. 20th ed. American Public Health Association. Washington .
5. Al-Samraee, T. H. (1987) Science of Bacteriology. Institution of Technical Institutions. (200 pages) .
6. Al- Ani, F. A and Ameen S. B. (1990).Fundamentals of Microorganisms.Ministry of Higher Education and Scientific Research. University of Mosul .
7. Al-Rifaee, M. H.(2005) Quality Aspects of Al-Marw Valley Basin Water and its Effect on the Quality of Tigris River. MSc Thesis, College of Sciences, University of Mosul.
8. Al-Mandeel, F. A. (2005) Environmental-Limnological Study of Phytoplankton in the Regulation Lake of Mosul Dam. MSc Thesis, College of Sciences, University of Mosul .
9. Al-Ubaidi, H. H. (2010) An Environmental Study of the Quality of Groundwater in the North of Salahaldin Province. MSc Thesis, College of Sciences, University of Tikrit.
10. Knna, A.M. (2006) Study of groundwater quality in Al- Gogjaly village and its suitability uses. Tikrit Journal of Pure Science. (2)11: 138-143.
11. Al-Shwani, T. M. (2009) The Microbial Indictors of Biological Contamination and Their Relation to Some Chemical and Physical Factors that Affect Them of Some Environmental and Water Systems in Kirkuk Province, PhD Dissertation, College of Education, Tikrit University.

12. Central Organization for Standardization and Quality Control (1996). Iraqi Standard Qualities of Drinking Water. The Draft of Updating Iraqi Standards No. (417)
13. (Committee on Environmental and Occupational Health (Canada).(2003) .
14. US-EPA(United State– EnvironmentalProtection Agency).(2002).Ground water and drinking waterstandards:National primary drinking water regulation. 816-F:02-03.
15. Helfrich L. A. P. Jams, and N. Richard (2005). Guide to understanding and managing lakes, part 1, and Physical measurement publication 420-538.
16. Darwish, s. F. (2011). environmental study and diagnostic of algae in groundwater areas and around Tikrit elected. MSc thesis, Collage of science, University of Tikrit.
17. Al-Ubaidi, M. A. (2014) An Environmental Study of the Quality of Groundwater in Al-Tuz District and its Villages. MSc Thesis, College of Sciences, University of Tikrit .
18. WHO(World Health Organization). (1999). Guideline for Drinking Water Quality, 2nd. Ed. Vol. 2. Geneva.
19. Mahdi, M. J. (2008) Studying Groundwater in Samra'a and Trying to Enhance its Quality Using the Method of Chemical Deposition and Ionic Exchange. MSc Thesis, College of Engineering, University of Tikrit.
20. Abdul Qader, U. N. and Ghazal, I. K. (2009). Hydrochemistry and Assessment of Groundwater Quality of Al-Shekan-Bartella Area (Northern Iraq) . Tikrit Journal of Pure Science . 14(1):5-25p.
21. PotaPova , M. and Charles , D.F. (2003). Distribution of Benthic diatoms in U. S .rivers in relation to conductivity and ionic composition . Fresh water Biology . 48: 1311-1328 .
22. WHO (World Health Organization**) .**(2004). Guidelines for Drinking-water Quality.Geneva.
23. Al-Rishawi, A. B and Hussein, K. H. (2006) A Study On Environmental Pollution Of Water Of Rumatha River And Its' Suitability For Human Use. Al-Taqani.Technical Researches- Foundation of Technical Education-Iraq. 9(2) 19-28.
24. Nidawi, M. G. (2010). an environmental study of the physical properties and chemical and bacteriological of some wells in Tikrit. MSc thesis, Collage of science, University of Tikrit.
25. Fatah, S. H.(2015) Evaluation of the Quality of Some wells in Kirkuk Province. PhD Dissertation, College of Science, University of Tikrit.
26. Morgan , P. (1990). Rural water supplies and sanitation . Hong Kong .Macmillan Education Limited. 7(17) :58-59.
27. Prescott, Lansing M. ; Harley, John p. ; Klein, Donald A. (2005). Microbiology. Six Edition . McGraw-Hill Companies . New York. Inc. USA. 992p .
28. Abdulbaqi, Y. T. (2008). The Suitability of Groundwater for Various Uses in Qaraqush Area (North East of Mosul City) the 6th Annual Conference of Dam and Water Resources Research Center, University of Mosul.
29. Jibreel, N. M. (2006) Environmental Study of the Quality of Groundwater in Hilla City. MSc Thesis, College of Sciences, University of Babylon.
30. WHO (World Health Organization) (1996). Guideline for Drinking Water Quality.Health Criteria & Other Supporting information. (2nd ed.),2 Geneva.

*****