Qatar Univ. Sci. Bull. (1986), 6 : 273 – 285

WATER QUALITY OF THE AREA WEST OF KARAK CITY, JORDAN

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Key words : Water – Quality – Karak – Jordan.

ABSTRACT

The water quality of some wells, wadis and springs in the area west of Karak City has been evaluated for irrigation and domestic uses, by the application of Wilcox (1955) and Doneen (1961) methods, as well as the standards of the World Health Organization (1971). The results of evaluation showed that :

80 % of the studied samples are of high salinity hazard and low sodium hazard, according to Wilcox (1955).

48 % of the samples are from the first class for irrigation, (in case of a soil of high permeability) according to Doneen (1961).

76 % of the samples are suitable for domestic uses according to the standards of the World Health Organization (1971).

INTRODUCTION

The study area is a part of the Jordan Rift Valley, and it lies at the southeastern coast of the Dead Sea (Fig. 1). It has an area of about 250 km^2 with an elevation ranging between and 350 m below sea level, and a general slope towards the west. It is partially cultivated where water is available from wells, wadis (e. g. Wadi Ibn Hammad, Wadi Karak, Wadi Dhira' and Wadi Isal), and springs (e. g. Ain Sikkin, Ain Merwiha and Ain Magarah), (Fig. 2). Rains fall during the period lying between October and April. The average annual precipitation is 50 mm (at the west) and 300 mm (at the east). Salameh and Shaqour (1981) classified the water of this area as alkaline.

Surface rocks consist of sandstones and limestones of Cambrian and Cretaceous age, as well as Cenozoic marls and alluvial deposits. In the subsurface, these rocks form good aquifers.

The present study is based on the results of the chemical analysis of 25 water samples. The raw data have been taken from Salamch and Shaqour (1981) which are quoted here in (Table – 1).

Evaluation of Water Quality of The Area West of Karak for Irrigation

A – By Wilcox (1955) Method :

This method depends on the relation between the electrical conductivity of water (in micromohs), and the sodium absorption ratio (SAR). The SAR can be estimated as follows :

$$SAR = \frac{Ma^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}} \quad (Meq / L)$$

Fig. (3) shows the classification of the water of the study area by using Wilcox (1955) diagram. The results can be summarized as follows :

80 % of the samples are of high salinity hazard and low sodium hazard (samples nos. 4 – 15, 18 – 25).

4 % of the samples are of very high salinity hazard and low sodium hazard (sample no. 3).

12 % of the samples are of very high salinity hazard and medium sodium hazard (samples nos. 1, 2, 17).

4 % of the samples are of very high salinity hazard and very high sodium hazard (sample no. 16). As this sample has very high salinity, it could not be plotted on Wilcox diagram.

B – By Doneen (1961) Method :

In his classification of irrigation water, Doneen (1961) depended on the following factors :

1 – Potential (or effective) salinity.

2 – Permeability (or sodium) index.
3 – Concentration of toxic substances.

1 – The Potential (Effective) Salinity :

According to Doneen (1961), the potential salinity is estimated as follows :
Potential salinity = $Cl + 1/2\ SO_4$ (Meq / L).

On the basis of the potential salinity, Doneen (*op. cit.*) subdivided the irrigation water into three classes as follow :

Class of Water / Soil Characteristics	Class I Meq / L	Class II Meq / L	Class III Meq / L
Soil of low Permeability	Less than 3	3 – 5	More than 5
Soil of medium Permeability	Less than 5	5 – 10	More than 10
Soil of high Permeability	Less than 7	7 – 15	More than 15

The potential salinity of the majority of the analysed water samples ranges between 4.52 Meq / L and 17.66 Meq / L. Only sample no. 16 has a potential salinity of 208.85 Meq / L.

On the basis of Doneen classification, the studied water samples are evaluated as follows ;

In The Case of a Soil of High Permeability :

48 % of the samples ae from the first class for irrigation (samples nos. 4 – 8, 11, 18, 20, 21, 22, 24, 25).
32 % of the samples are from the second class (samples nos. 9, 10, 12 – 15, 19, 23).
20 % of the samples are from the third class (samples nos. 1, 2, 3, 16, 17).

In The Case of a Soil of Medium Permeability :

20 % of the samples are from the first class (nos. 4, 7, 20 – 22).
52 % of the samples are from the second class (nos. 5, 6, 8, 9, 11 – 15, 18, 23 – 25).
28 % of the samples are from the third class (nos. 1 – 3, 10, 16, 17, 19).

In The Case of a Soil of Low Permeability :

20 % of the samples are from the second class (nos. 4, 7, 20 – 22).
80 % of the samples are from the third class (the remaining samples).

2 – The Permeability (Sodium) Index :

The permeability index is estimated as follows (cf. Doneen, 1961):

$$\text{Permeability index} = \frac{Na^+ + \sqrt{HCO_3}}{Na^+ + Mg^{++} + Ca^{++}} \times 100 \text{ (Meq / L)}$$

On the basis of the relation between the permeability index and the total salinity, Doneen (*op. cit.*) established a diagram which he subdivided into three subdivisions representing three classes of water. Also, Doneen provided three types of this diagram to accommodate the different types of soil.

The permeability index of the analysed samples was calculated and plotted on Doneen diagram (Fig. 4). Only 19 of these sample could be represented, whereas the remaining ones (nos. 1 – 3, 16, 17, 19) have a high total salinity, and they are considered to be unsuitable for irrigation.

The classification of the studied samples (in the case of a soil of medium permeability) is shown in Fig. 4. The results can be summarized as follows :

72 % of the total samples are of the first class (nos. 4 – 15, 18, 20, 21, 23 – 25).
4 % of the samples are of the second class (no. 22).
24 % of the samples are of the third class (nos. 1 – 3, 16, 17, 19).

3 – Concentration of Toxic Substances :

It has been proved that boron is the most important element, which if present in high concentration, it would have a bad effect on plants. Several classifications were based on the concentration of this element, among which the following is widely accepted ; (cf. Doneen, 1961).

Class of Irrigation Water	**Class I**	**Class II**	**Class III**
Concentration of Boron	Less than 0.5 mg / l	0.2 – 2.0 mg / l	More than 2.0 mg / l

However, the concentration of boron was not estimated in the studied samples and no information concerning its presence or absence is available.

Evaluation of Water Quality of The Area West of Karak for Domestic Uses

To be suitable for domestic uses, water must have special bacteriological, physical and chemical characteristics. It must be free from harmful bacteria and other microbs. Also, it should be colorless, oderless and have an acceptable taste.

Chemically, water must not contain objectionable amounts of certain elements. No universal classification has yet been provided for evaluating the chemical characteristics of water used for domestic puposes. However, the standards recommended by the World Health Organization (1971) will be considered here (Table – 2).

According to these standards, 76 % of the studied water samples are suitable for domestic uses (samples nos. 4 – 15, 18, 20 – 25), whereas the remaining ones (nos. 1 – 3, 16, 17, 19) are unsuitable as they contain high amounts of certain ingredients, and this is shown below :

Total Dissolved Solids : 80 % of the samples contain suitable amounts of the total dissolved solids (nos. 4 – 15, 18 – 25).

Calcium : The concentration of calcium in the studied samples ranges between 33 and 371 ppm. Accordingly, all of these samples (except sample no. 16) are suitable for domestic uses.

Magnesium : All of the studied samples contain suitable concentration of magnesium, except sample no. 16.

Sodium : The acceptable concentration of sodium is not mentioned by the World Health Organization (1971). According to the U. S. A. standards (cf. Davis and de Wiest, 1966), water used for domestic purposes should not contain sodium in amount exceeding 200 ppm. Accordingly, 76 % of the studied samples (nos. 4 – 15, 20 – 25) are suitable.

Chlorides : All of the studied samples contain suitable concentration of chlorides, except sample no. 16.

Sulphates : 84 % of the studied samples contain suitable amounts of the sulphates (nos. 4 – 16, 18 – 25).

Bicarbonates : All of the studied samples contain suitable concentration of the bicarbonates.

Nitrates : All of the studied samples (except sample no. 16) contain suitable concentration of the nitrates.

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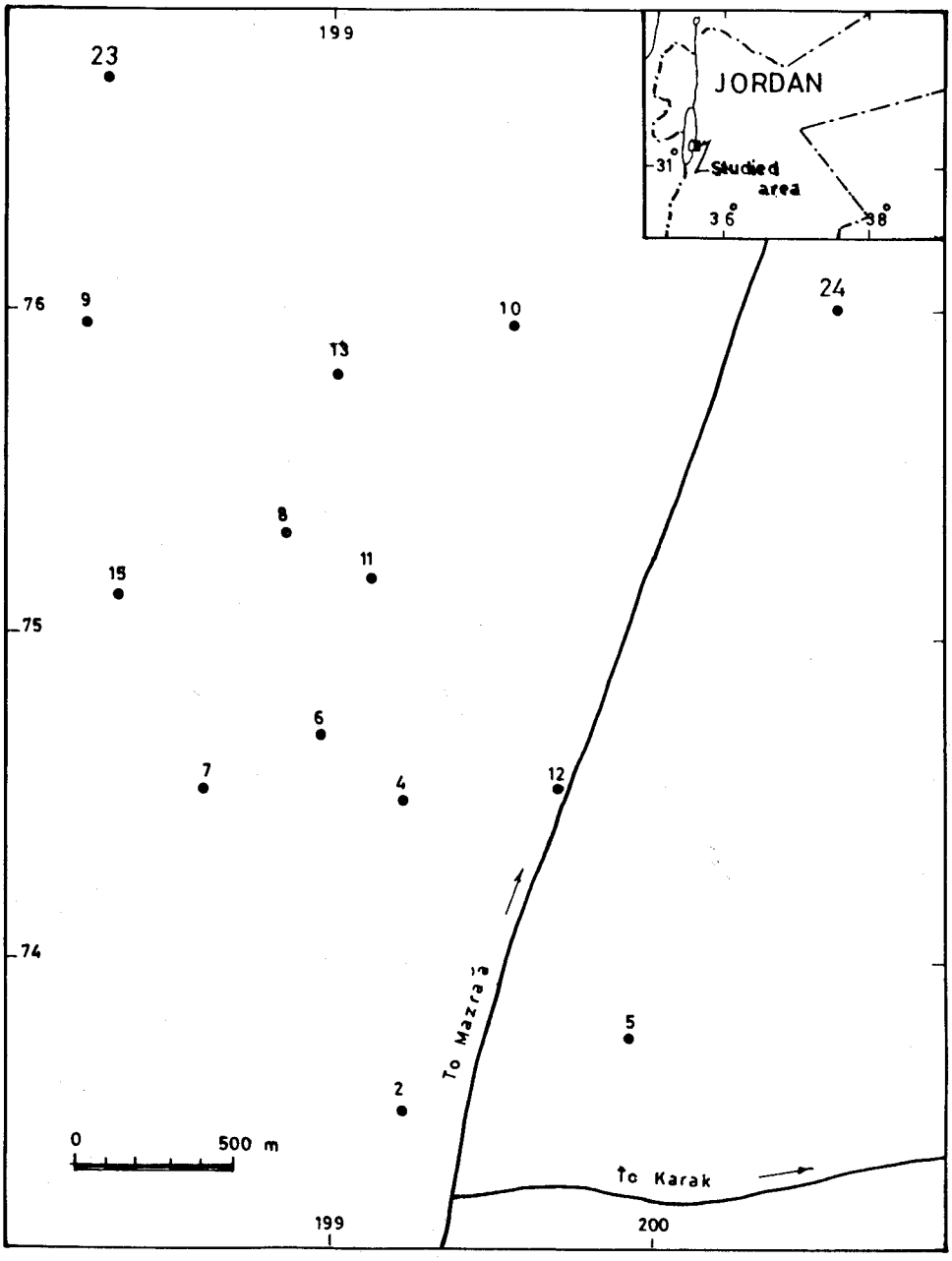

Fig. 1 : Location map of the studied wells (after Salameh and Shaqour, 1981).

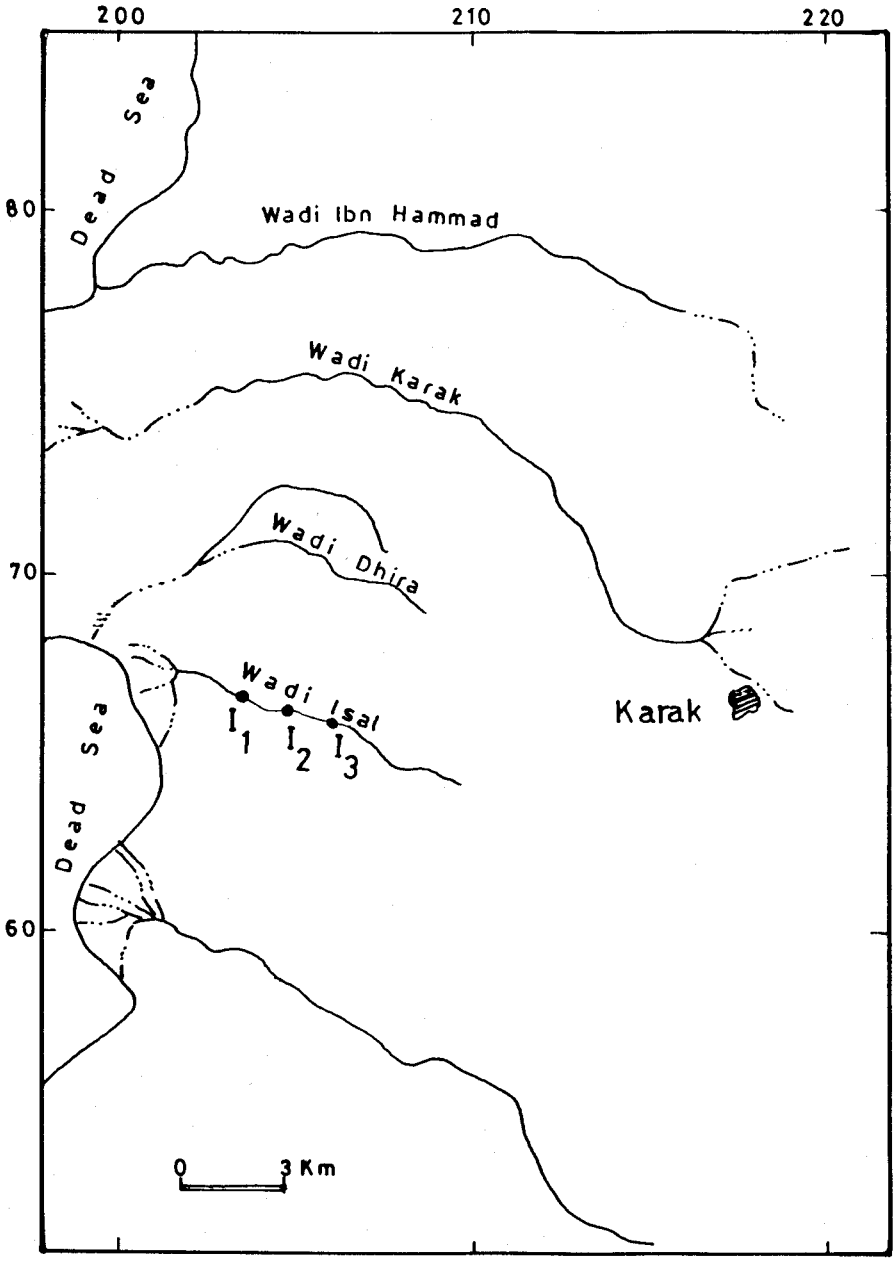

Fig. 2: Location map of the major streams in the study area (after Salameh and Shaqour, 1981).

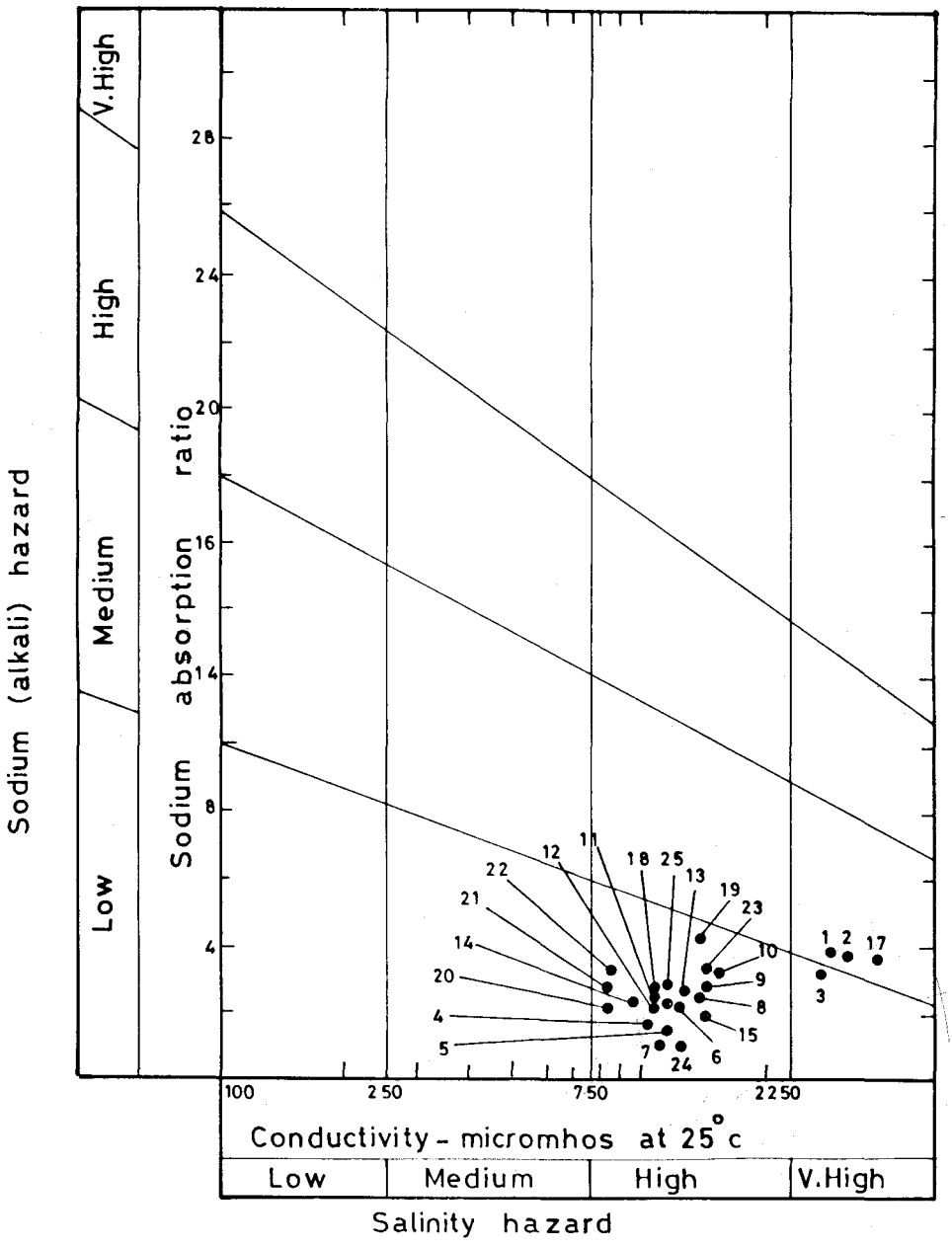

Fig. 3: Classification of the studied water samples, for irrigation, using Wilcox (1955) diagram.

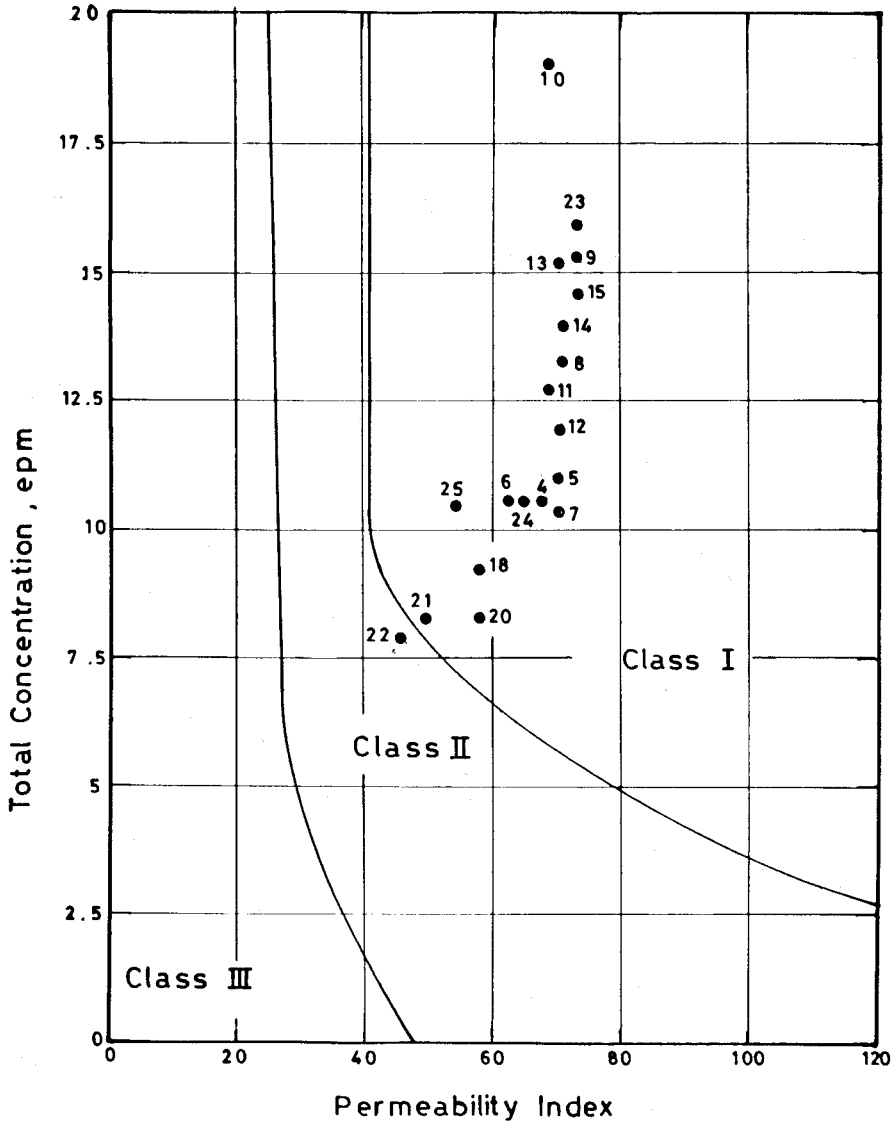

Fig. 4: Classification of the studied water samples, for irrigation, using Doneen (1961) diagram (for a soil of medium permeability).

Table 1

Chemical analysis of wells, springs and wadis in the study area
(after Salameh and Shaqour, 1981).

Sample no.	Name	E.C. M/mhos /cm	T.D.S. p p m	Na m.eq /l.	K m.eq /l.	Mg m.eq /l.	Ca m.eq /l.	Cl m.eq /l.	So_4 m.eq /l.	HCO_3 m.eq /l.	NO_3 m.eq /l.	pH
1	I_1	2593	1660	10.5	0.78	8.56	6.84	13.38	8.56	4.44	0.21	7.50
2	I_2	2600	1663	10.3	0.96	9.64	6.64	10.39	12.16	4.76	0.24	7.40
3	I_3	2532	1620	9.2	0.93	9.59	7.05	9.11	13.72	4.80	0.27	7.50
4	M_2	997	638	3.5	0.19	2.98	3.84	3.51	2.02	4.90	–	7.60
5	M_3	1105	731	3.57	–	3.00	4.44	4.05	2.79	4.20	–	–
6	M_4	1173	704	4.3	–	3.06	3.16	4.50	1.95	3.84	–	7.90
7	M_5	1045	627	3.0	–	3.70	3.70	3.53	2.60	5.21	–	7.85
8	M_6	1334	854	4.7	0.21	3.50	4.70	5.33	3.10	4.20	0.51	7.45
9	M_7	1503	902	5.2	–	6.20	4.00	5.42	3.35	5.67	–	7.40
10	M_8	1740	1114	7.7	0.61	5.80	4.88	12.03	1.96	5.00	–	7.55
11	M_9	1122	718	4.5	0.33	3.52	4.48	4.900	3.44	4.34	0.16	7.62
12	BN-305	980	710	4.35	0.31	3.52	3.68	4.90	4.58	2.40	–	8.20
13	BN-307	1200	870	5.4	0.21	3.70	5.80	7.04	3.44	4.60	–	7.50
14	BN-308	1100	800	4.73	0.36	3.61	4.69	5.07	5.10	3.20	–	7.50
15	BN-310	1430	915	4.7	0.24	4.26	5.16	5.68	4.16	4.20	0.39	7.6
16	D_2	19521	12493	146.0	11.20	68.35	18.51	195.3	27.10	0.34	0.88	6.08
17	B	2593	1660	10.5	0.78	8.56	6.84	13.38	8.56	4.44	0.20	7.30
18	W. Isal	939	601	4.0	0.25	2.16	3.08	3.850	3.18	3.47	0.10	7.55
19	W. Ahiemer	2170	1389	10.0	0.64	5.88	5.20	10.03	6.50	4.92	0.14	7.70
20	W. Dhira'	768	492	3.2	0.16	1.83	2.64	3.10	1.83	2.54	0.06	8.25
21	W. Karak	784	502	4.1	0.24	1.68	1.96	3.85	1.84	1.96	0.05	8.60
22	W. Ibn Hammad	811	519	4.5	0.19	1.76	1.64	3.80	1.72	2.30	0.07	8.45
23	Ain Spear	1600	1024	5.4	0.30	4.74	5.56	6.98	3.88	4.88	0.27	7.50
24	Ain Sikkin	1019	652	3.85	0.23	2.74	3.54	4.12	2.32	3.82	0.11	7.65
25	Ain Magarah	1053	674	5.1	0.24	2.58	2.60	4.96	2.06	3.38	0.07	8.45

Table : 2

Maximum permissible levels of different substances in water used for domestic purposes (cf. World Health Organization, 1971).

Substance	Maximum permissible level (ppm)
Total dissolved solids	1500.00
Calcium	200.00
Megnesium	150.00
Manganese	0.50
Iron	1.00
Copper	1.50
Zinc	15.00
Chlorides	600.00
Sulphates	400.00
Bicarbonates	500.00
Nitrates	45.00

دراســـــة عــن
صـلاحية ميـاه منطقـة غـرب الكـرك بالأردن

حامـد أحمـد النخـال و محمـد محمـود عاشـور

قُيمت صلاحية مياه بعض الآبار والوديان والينابيع في منطقـة غرب الكرك ، لإستخـدامهـا في الري والأغراض المنزليـة ، وأُتبـع في ذلـك طريقـة كلٍ من ويلكـوكس (١٩٥٥) ودونين (١٩٦١) والمعدلات المعمول بها لدى منظمة الصحة العالمية (١٩٧١) ، وقد دلت نتائج التقييم على أن :

٨٠ ٪ من العينات المدروسـة تحتوي على ملوحـة عـاليـة الخطورة ، وصوديوم قليل الخطورة ، بناءً على طريقة ويلكوكس (١٩٥٥) .

٤٨ ٪ من العينات من الدرجة الأولى للري ، في حالة التربة ذات النفاذية العاليـة ، بنـاءً على طريقة دونين (١٩٦١) .

٧٦ ٪ من العينـات صـالحـة لـلأغراض المنزليـة ، بنـاءً على معـدلات منظمـة الصحـة العـالميـة.