EVALUATION OF GROUNDWATER PROPERTIES IN BORDERLINE BETWEEN IRAQ AND KINGDOM OF SAUDI ARABIA FOR DIFFERENT USES

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ABSTRACT

The properties of groundwater in some wells digging on the border of Iraq with KSA along 400 km from Al-Nekheab at west to Al-Salman at south of Iraq were evaluated. Eleven wells were chosen as a case study depended on variable of water depth and stratum properties. Water samples were taken at two periods the first one at summer and the other at winter reason. The chemical properties of these samples were compared with the standard limits to evaluate the quality of water for different uses. The main parameters used for evaluation process are negative and positive ions, total dissolve salt, electrical conductivity, and turbidity.

Finally, conclude the usages of water of investigated wells were un-permitted for drinking purposes except well No.10 unless treated by purifying process, but can be used for irrigation for soil which has high permeability and good drainage in addition to plant have high strength for salinity. In the other side all wells mostly used for livestock usages and poultry.

For industrial usages only well No.(10) can be used for industry of cement. While all wells can be used for building purposes except wells No. (1, 2, 7, 11).

Key words: TDS, Electrical conductivity, Turbidity, Drinking water standards, Industrial water standards.

تقييم خواص المياه الجوفية في الحد الفاصل بين العراق والسعودية للاستعمالات المختلفة

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الخلاصة

تهتم هذه الدراسة بتقييم خواص المياه الجوفية في بعض الابار التي حفرت في مواقع على الشريط الحدودي العراقي مع الجانب السعودي وبطول 400كم بدا من النخيب في غرب العراق وحتى السلمان في جنوب العراق. اختير احد عشر بئرا اعتمادا على عمق الماء وخواص الطبقة. جمع العينات كان في فترتين زمنيتين، الاولى في الصيف والاخرى في الشتاء. المواصفات الكيميائية لهذه العينات قورنت مع المعايير المطلوبه لكل استعمال لغرض تقييم ملائمة نوعية هذه المياه مع تلك الاستعمالات. المقاييس الرئيسية التي استعملت في عملية التقييم شملت الايونات السالبة والموجبة والاملاح الذائبة الكلية بالاضافة الى العكورة والموصلية

الكهربائية. خلصت الدراسة الى ان مياه هذه الابار ماعدا البئر رقم (10) لايمكن استعمالها لاغراض الشرب مالم يتم استعمال عمليات التنقية لكن يمكن استعمال مياه هذه الابار في ري المخاصيل الزراعية التي لها مقاومة جيدة للملوحة وفي اراضي ذات نفاذية عالية وتصريف جيد. ومن ناحية اخرى غالبا كل الابار يمكن استعمالها للماشية والدواجن. اما في الصناعة ففقط البئر رقم (10) يمكن استعماله في صناعة السمنت بينما كل الابار يمكن استعمال مياهها لاغراض البناء ما عدا الابار (1, 2, 7, 11)

List of Acronyms	
Ca^{++}	Calcium
Cl^{-1}	Chloride
CO_3	Carbonate
EC	Electrical conductivity
FAO	Food and Agriculture Organisation
H_2S	Hydrogen Sulphide
HCO^3	Bicarbonate
IDWS	Iraqi Standard for Drinking water
K^+	Potassium
Mg^{2+}	Magnesium
MoH	Ministry of Health
Na^+	Sodium
NO^{-3}	Nitrate
OSC	Organization of Central of Statistic
pH	Hydrogen Ion Concentration
PO^{-4}	Phosphate
mg/l	Parts per million
SAR	Sodium Adsorption Ratio
SO^{-4}	Sulphate
T.H	Total Hardness
TDS	Total Dissolved Salt
WHO	World health organisation
w.c.t	With compared to

INTRODUCTION

Water plays important roles in the life of the community, as it needs to sustain life directly by using it for drinking and in making its own food, and indirectly, as in agriculture, industry, power generation, health and other services. Investigation of alternative resources for surface water was the main task for researchers because shortage and the degradation of surface water quality at last 10 years ago. Climate change in the world and extreme Iraq's climate (dry and lower rainfall about 40 cm^3/year)(MoE 2006) rising importance of groundwater studies. So many researchers were

studied groundwater properties such as the water quality and its effect on nutrients availability for corn in Sulaimania region was studied by Mam Rasool (Mam Rasool, 2000). Also Al-Manmi was Investigates chemical and environmental of groundwater in Sulaimaniya City and there uses (Al-Manmi,2002). While Sadiq was discusses groundwater availability in south of Iraq (Sadiq,2013) as well as Al- Husseini was analyse groundwater flow of Bahr Al-Najaf Area (Al- Husseini,2013) also Al-salim was discusses recharging of groundwater processes in Wadi Al-Kassab Catchment's Area(al-salim,2013). The Iraq land were divided into five physiogarghic zones (Sadiq 2013) as illustrated in **Figure (1)**, the zone number five (region of study) has deep water aquifer and lower quantity.

DESCRIPTION OF THE REGION OF STUDY

The distributions of investigated wells were on the border strip between Iraq and KSA along 400km from Al-Nekheabe at west of Iraq to Al-Salman at south of Iraq. This wide area not have any surface water resources (rivers, canals, lakes …etc.). Therefore, it is depended mainly upon groundwater. The geological description of this area is sand valleys with hard stratum for sand and calcite rocks (Sadiq 2013). Eleven wells were used for evaluation the quality of water for different uses. All wells information's were listed in **Tables (1) and (2)**. Tests were executed in labs of environment directorate of Baghdad in 2008.

SUITABLE OF GROUNDWATER USES

Drinking water

The using of water for drinking purpose required meeting water specifications for drinking usages. WHO and IDWS were presenting a limitations for using water for drinking as listed in **Table (3)** (IDWS 1998; WHO 2006) . **Figures from (2) to (10)** can observing all wells found hade over in Ca^{++}, Mg^{++}, Na^{-}, and T.D.S except well No. (10), all wells agreement with pH value except well No. (11), and all wells have hardness, so groundwater of well No. (10) can be used for drinking purpose when an process used to eliminate sulphate.

Irrigation usage

"The water used in irrigation depends on type of soil and kind of plant" (Al-Saed 2006). Wilcox, Schofield, Doneen, Eaton, and Thorne and Thorne were presented more than system to classification the irrigation water(Al-Manmi 2008). While in this study procedures of USA salinity Lab. was used. It can be classified the water for many zones depending on Sodium Adsorption Ratio (SAR) and Electrical Conductivity(EC) as illustrated in **Figure (11)**. The usage of wells water for irrigation can be evaluated. The water characteristic of all wells except well No. 10 can be used for soil which has high permeability and good drainage in addition to plant have high strength for salinity, while water of well No. 10 can be used for irrigation for most plant, as shown in **Table(4)**.

Livestock drinking usages

Livestock have an ability to drinking water with ionic concentration more than human ability (Clark 1977), so properties of water used for livestock drinking were lower than for humane drinking use. Ayers and Westcot presented a classification for drinking water for livestock as shown in **Table(5)** (Ayers 1994). A according to this classification well No. (10) regarded has

excellent rating, wells No.(1,2,4,6,7,9,11) has very satisfactory rating, and wells No. (3,5,8) has satisfactory rating for livestock but unfit for poultry.

Industrial usages

The industries that may be construct in study zone, according to availability of raw materials and there circumstances, were cement and oil industries. Water standard for cement and oil industries usages was presented by Hem as illustrated in **Table (6)**(Hem 1991). Therefore just well No.(10) was satisfies requirements for industry of cement while other wells may be need other treatments. **Table (7)** summarize evaluations for industrial usages.

Water for building usage

Classifications of Altoviski, shown in **Table (8)**(Al-Manmi 2008), for water that use in building usages, the wells water were evaluated. All wells can be used for this purposes except wells No. (1, 2, 7, 11) because this wells have (Mg^{++}) ion over water requirements.

CONCLUSIONS

The deducing was obtaining according to previous evaluations, were the location of well and excavation level with respect to sea level don't have effect on water properties, also the behaviour of concentration of anions, cations, and T.H. for investigated wells was approximately the same. Moreover the usages of water of investigated wells were un-permitted for drinking purposes because have high concentration of anions, cations, and hardness except well No.10 unless treated by purifying process. For irrigation all wells except well No. 10 can be used for soil which has high permeability and good drainage in addition to plant have high strength for salinity, while water of well No. 10 can be used for irrigation for most plant. While for livestock usages all wells mostly used for livestock usages and poultry.

For industrial usages the investigated wells were showed weakness for industrials usages except well No.(10) that satisfies requirements for industry of cement. While all wells can be used for building purposes except wells No. (1, 2, 7, 11).

REFERENCES

[1] Al- Husseini, T. R. Abdul-Mehdi, (2013), " Transient Groundwater Flow Analysis of Bahr Al-Najaf Area Using Fuzzy Approach", Department of Civil Engineering, College of Engineering, University of Al-Mustansiriyah, Ph.D. thesis.

[2] Al-Manmi, D. A. M. A. (2008), "Water Resources Management in Rania Area Sulaimaniyah NE- IRAQ". Department of Geology, College of Science, University of Baghdad, . Ph.D. thesis.

[3] Al-Saed, K., and N., Fatihy (2006), "Validity and observation acceptable the irrigation water". recommended paper, agriculture research centre, Egypt

[4] Al-Salim, T. H., (2013), "Rainwater Harvesting of Wadi Al-Kassab Catchment's Area by Weir Construction, West of Mosul City / North of Iraq", the international conference to achieve sustainable development in Iraq, ministry of higher education and scientific research, Baghdad, Iraq

[5] Ayers, R. S., and Westcot, D.W. (1994), "Water Quality for Agriculture Irrigation and Drainage", FAO, Rome, Italy. Paper 29, Rev. 1.

[6] Clark, J. W., Viessman, W. and Hammer, M.J. (1977), "Water Supply and Pollution Control". New York, USA., Welly & Sons.

[7] Hem, J. D. (1991), "Study and Interpretation of the Chemical Characteristics of Natural Water". USGS Water Supp. Paper no. 2254, 263.

[8] IDWS (1998), "Guidelines Standard for Drinking water". Public Halthy, Iraqi.

[9] Lamaddalena, N. (1997), "Integrated Simulation Modelling for Design and Performance Analysis of on-demand Pressurized Irrigation System", technical university of Lisbon, Lisbon. Ph.D. Dissertation.

[10] MoE (2006), "State of the environment in Iraqi company report 2006". Baghdad, Iraq. The Directorate of Maritime Inspection

[11] Mam Rasool, G.A., 2000, "Steady of water quality and its effect on nutrients availability for corn in Sulaimania region", M.Sc. thesis, Collage Of Agriculture, University of Sulaimania.

[12] Sadiq, J. B. (2013). "Groundwater in Iraq". the international conference to achieve sustainable development in Iraq, ministry of higher education and scientific research, Baghdad, Iraq.

[13] Suares, D. L., (1981), "Relation between PhC and SAR and alternate method of estimating SAR of soil or drainage water", Soil Science Society American journal 45:469-475.

[14] WHO, (2006), "Guidelines for Drinking Water Quality", Recommendations, 3rd ed. Geneva vol.1.

Table (1): Description of wells.

Well No.	Name of well	Elevation of excavation w.c.t sea level (m)	Elevation w.c.t sea level (m)	Direction	
				N	E
1	Al Amger	136	355.5	$31^0\ 02'\ 347''$	$42^0\ 13'\ 785''$
2	Al Bateen	87	372.3	$30^0\ 17'\ 304''$	$43^0\ 15'\ 913''$
3	Al Gazali	144	389	$30^0\ 19'\ 083''$	$43^0\ 19'\ 547''$
4	Al-Hakim	112	392	$30^0\ 20'\ 615''$	$43^0\ 27'\ 881''$
5	Al-Hamza	118	398	$30^0\ 14'\ 986''$	$43^0\ 29'\ 408''$
6	Treeq Al-Huseen	67	395	$30^0\ 03'\ 785''$	$43^0\ 34'\ 445''$
7	Al-Sufawi	70	390	$30^0\ 04'\ 507''$	$43^0\ 38'\ 999''$
8	Alfarise	70	400	$29^0\ 57'\ 309''$	$43^0\ 45'\ 846''$
9	Sallah	-30	230	$29^0\ 35'\ 154''$	$44^0\ 14'\ 504''$
10	Anssab	-44	198	$29^0\ 12'\ 000''$	$44^0\ 43'\ 077''$
11	Fatema	-130	110	$29^0\ 09'\ 036''$	$45^0\ 18'\ 067''$

Table (2): Water quality collected from wells.

No. of well	Well name	Ca^{++} mg/l	Mg^{++} mg/l	Na^{-} mg/l	Cl^{-} mg/l	SO_4^{-} mg/l	T.H mg/l	T.D.S mg/l	pH	Turbidity NTU
1	Al Amger	360	336	280	242	1290	1890	2040	7	58
2	Al Bateen	324	336	290	257	1290	1800	2140	6.92	86
3	Al Gazali	288	215	461	368	1260	1620	3756	7.64	4.19
4	Al-Hakim	396	215	301	334	1220	1890	2240	6.8	83.5
5	Al-Hamza	396	258	437	257	1116	2070	3618	7.28	7.52
6	Treeq Al-Huseen	360	150	343	183	827	1530	2658	7.92	5.45
7	Al-Sufawi	360	288	508	312	1236	2106	4188	7.61	50.12
8	Alfarise	360	215	438	212	1172	1800	3538	7.96	16.1
9	Sallah	357	152	221	2.5	677	1520	1480	7.54	278
10	Anssab	190	115	105	85	41	950	385	8.02	110
11	Fatema	722	184	300	325	177	2565	2230	6.18	3.8

Table (3): Water quality for Drinking Water (IDWS 1998; WHO 2006)

	Ca^{++} (mg/l)	Mg^{++} (mg/l)	Na^{-} (mg/l)	Cl^{-} (mg/l)	So_4^{-2} (mg/l)	T.H (mg/l)	T.D.S (mg/l)	pH	Turbidity NTU
IDWS	50	50	200	250	250	500	1000	8.5-6.5	-
WHO	75	125	200	250	250	----	1000	8.5-6.5	5

Table(4): EC, SAR, and evaluation of water for investigated well

No. of well	Well name	EC (dS/cm)	SAR(epm)	Zone
1	Al Amger	3.99	2.5	C4-S1
2	Al Bateen	4.22	2.7	C4-S1
3	Al Gazali	5.56	5.0	C4 -S1
4	Al-Hakim	4.44	3.0	C4-S1
5	Al-Hamza	4.68	4.2	C4-S1
6	Treeq Al-Huseen	3.736	3.8	C4-S1
7	Al-Sufawi	5.752	4.8	C4-S1
8	Alfarise	5.404	4.5	C4-S1
9	Sallah	2.870	2.5	C4-S1
10	Anssab	0.115	1.5	C1-S1
11	Fatema	4.53	2.6	C4-S1

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

Na^{-}, Ca^{++}, Mg^{++}, and SAR in (epm) (Suares,1981)

Table (5): Water quality for livestock and poultry usages (Ayers,1994)

EC (dS/m)	Rating	REM.
<1.5	Excellent	Usable for all classes of livestock and poultry
1.5-5.0	Very satisfactory	Usable for all classes of livestock and poultry. May cause temporary diarrhoea in livestock not accustomed to such water; watery droppings in poultry.
5.0-8.0	Satisfactory for livestock	May cause temporary diarrhoea or be refused at first by animals not accustomed to such water.
	Unfit for poultry	Often causes watery faeces, increased mortality and decreased growth, especially in turkeys.
8.0-11.0	Limited Use for livestock	Usable with reasonable safety for dairy and beef cattle, sheep, swine and horses. Avoid use for pregnant or lactating animals.
	Unfit for poultry	Not acceptable for poultry.
11.0-16.0	Very limited Use	Unfit for poultry and probably unfit for swine. Considerable risk in using for pregnant or lactating cows, horses or sheep, or for the young of these species. In general, use should be avoided although older ruminants, horses, poultry and swine may subsist on waters such as these under certain conditions.
>16.0	Not Recommended	Risks with such highly saline water are so great that it cannot be recommended for use under any conditions.

Table (6): Water quality standard for industrial usages(Hem 1991)

parameters	Cement factory	Oil industrial
Ca^{++} (mg/l)	----	75
Mg^{++} (mg/l)	-----	30
Cl^{-} (mg/l)	250	300
So_4^{-2} (mg/l)	250	----
pH	6.5 -8.5	6 -9
T.H (mg/l)	------	350

Table (7): Wells that Satisfies standard limitations for industrial usages.

Industrial	Mg^{++} (mg/l)	Ca^{++} (mg/l)	Cl^{-} (mg/l)	So_4^{-2} (mg/l)	PH	T.H (mg/l)
Cement	----------	----------	1,6,8,9,10	10,11	All	------
Oil	6,9,10	All	All	10,11	All	No one

Table (8): Water quality for building usages (Al-Manmi 2008).

Parameters	Ca^{++}	Mg^{++}	Na^{+}	Cl^{-}	So_4^{-2}	HCO_3^{-}
Permissible limit (mg/l)	437	271	1160	2187	1460	350

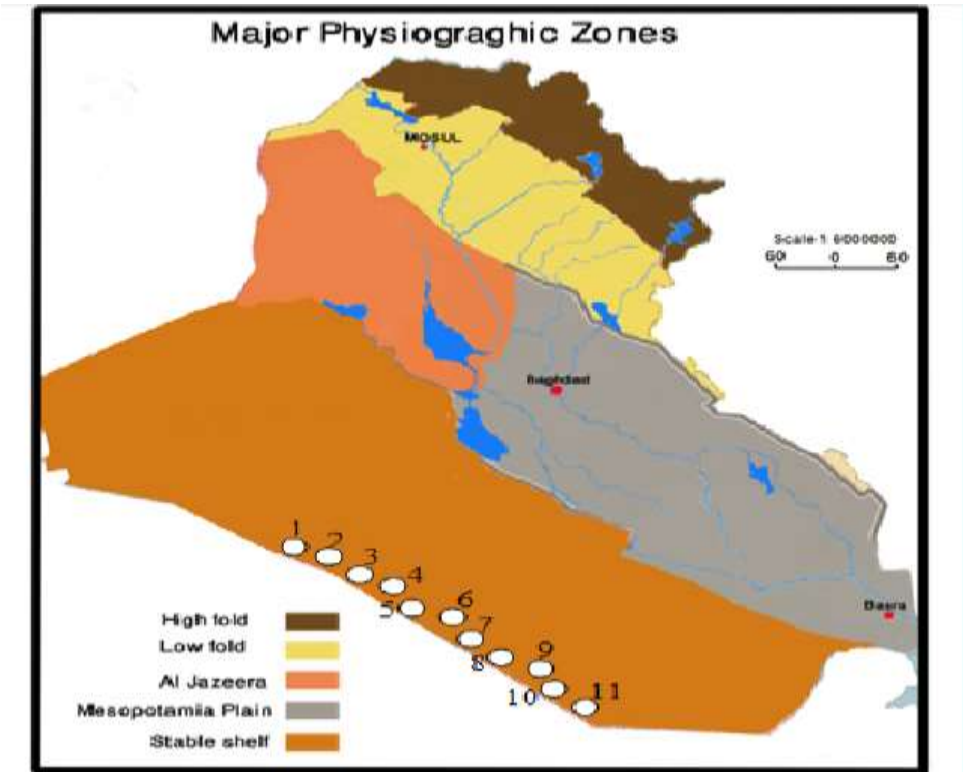

Figure (1): Locations of wells in Physiogarghic zone (Sadiq 2013)

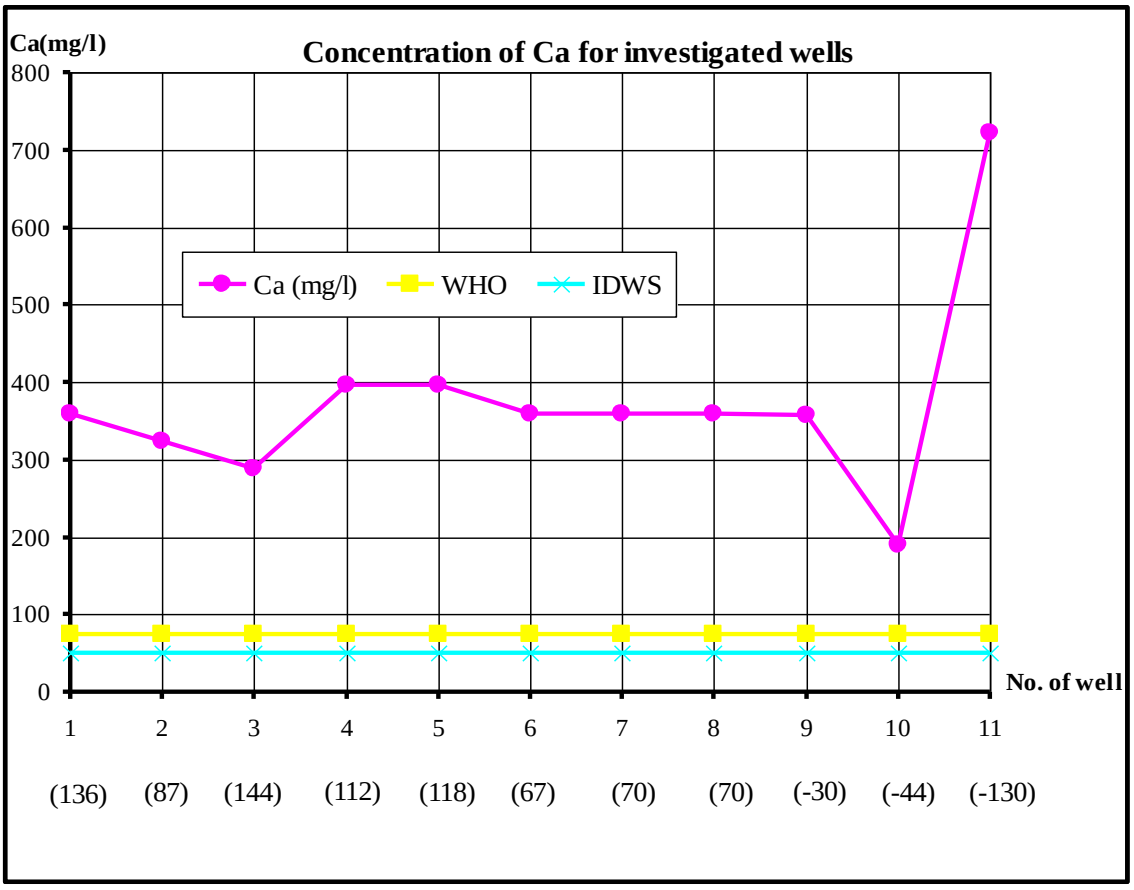

Figure (2): Concentration of Ca and Elevation of excavation w.c.t sea level (m).

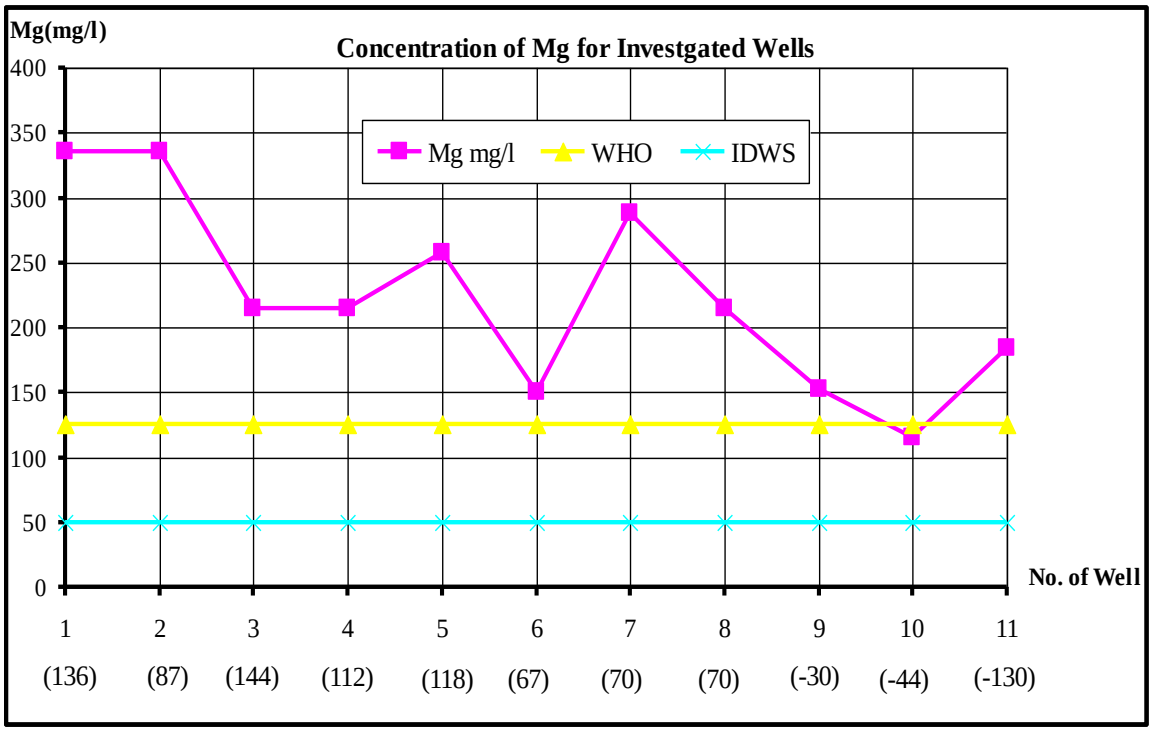

Figure (3): Concentration of Mg and Elevation of excavation w.c.t sea level (m).

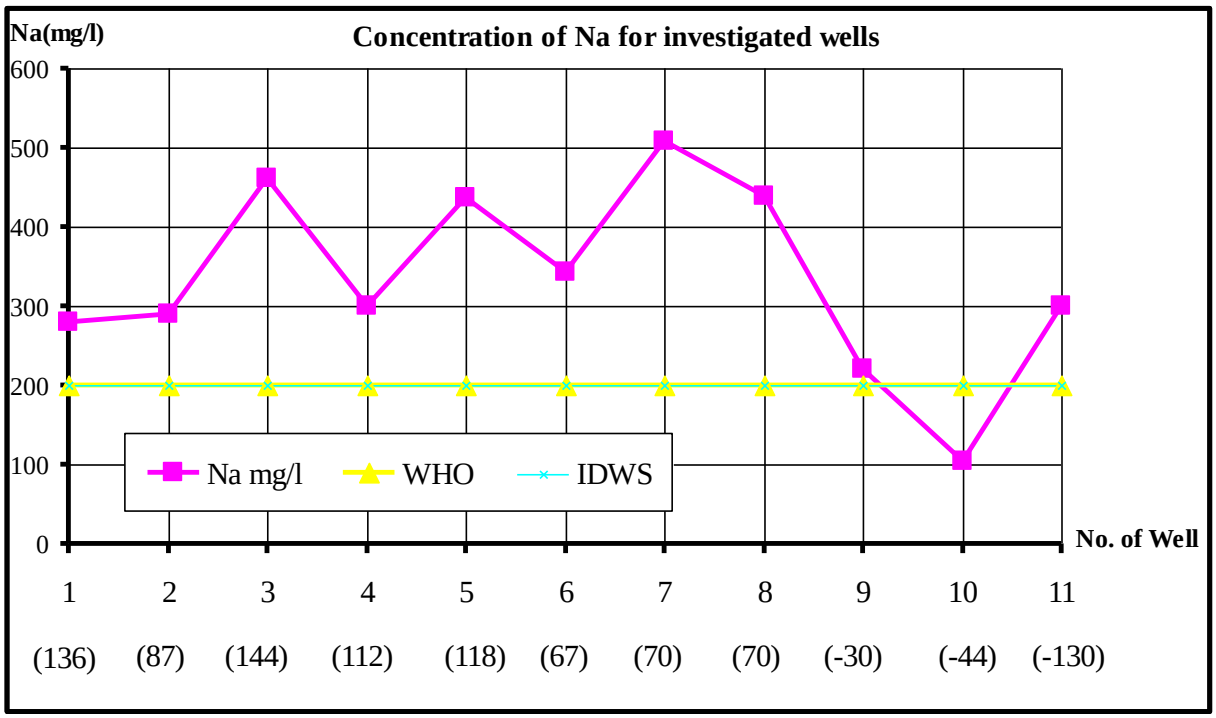

Figure (4): Concentration of Na and Elevation of excavation w.c.t sea level (m).

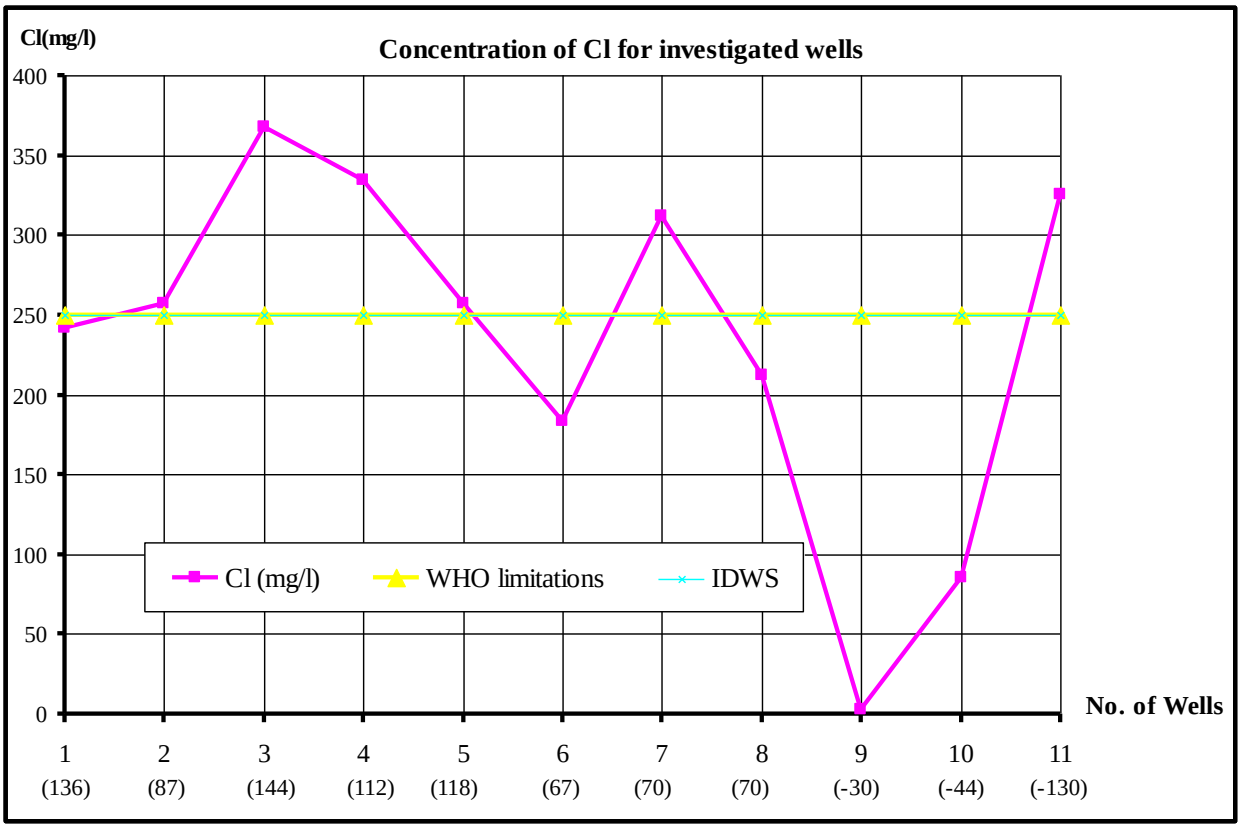

Figure (5): Concentration of Cl and Elevation of excavation w.c.t sea level (m).

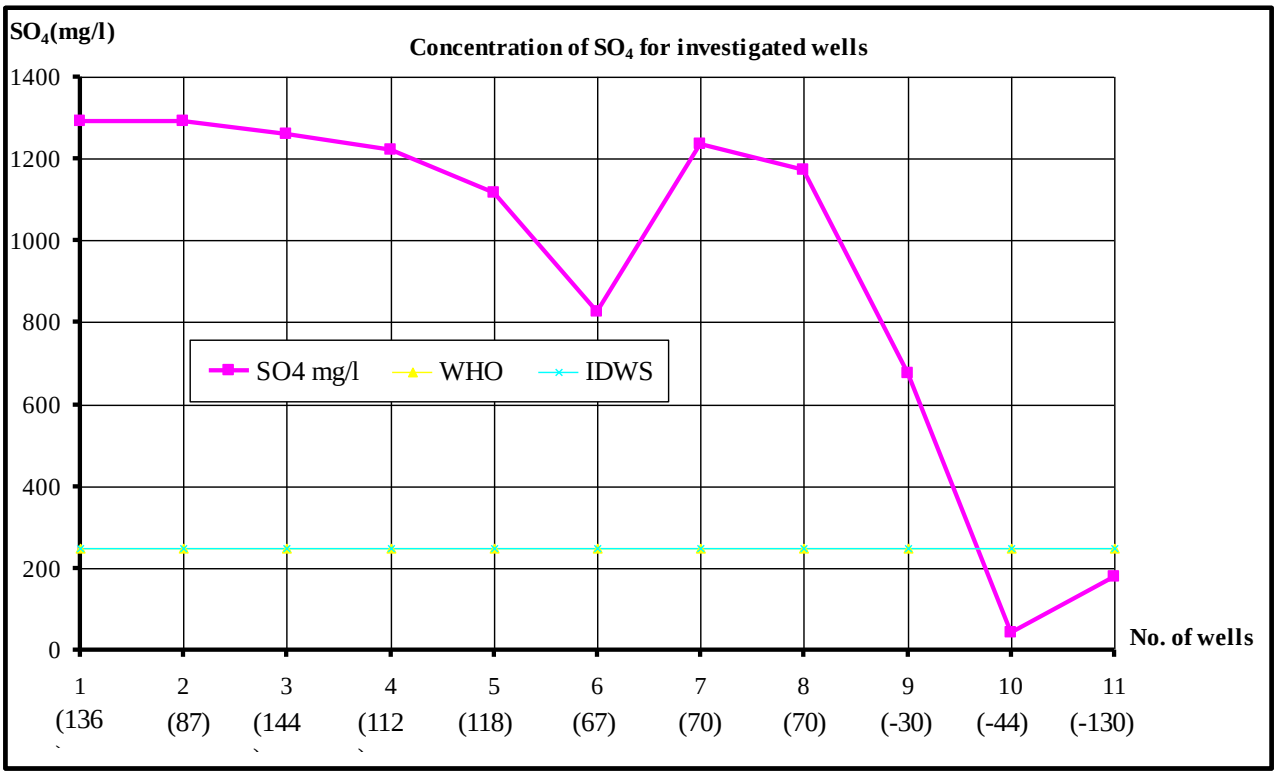

Figure (6): Concentration of SO4 and Elevation of excavation w.c.t sea level (m).

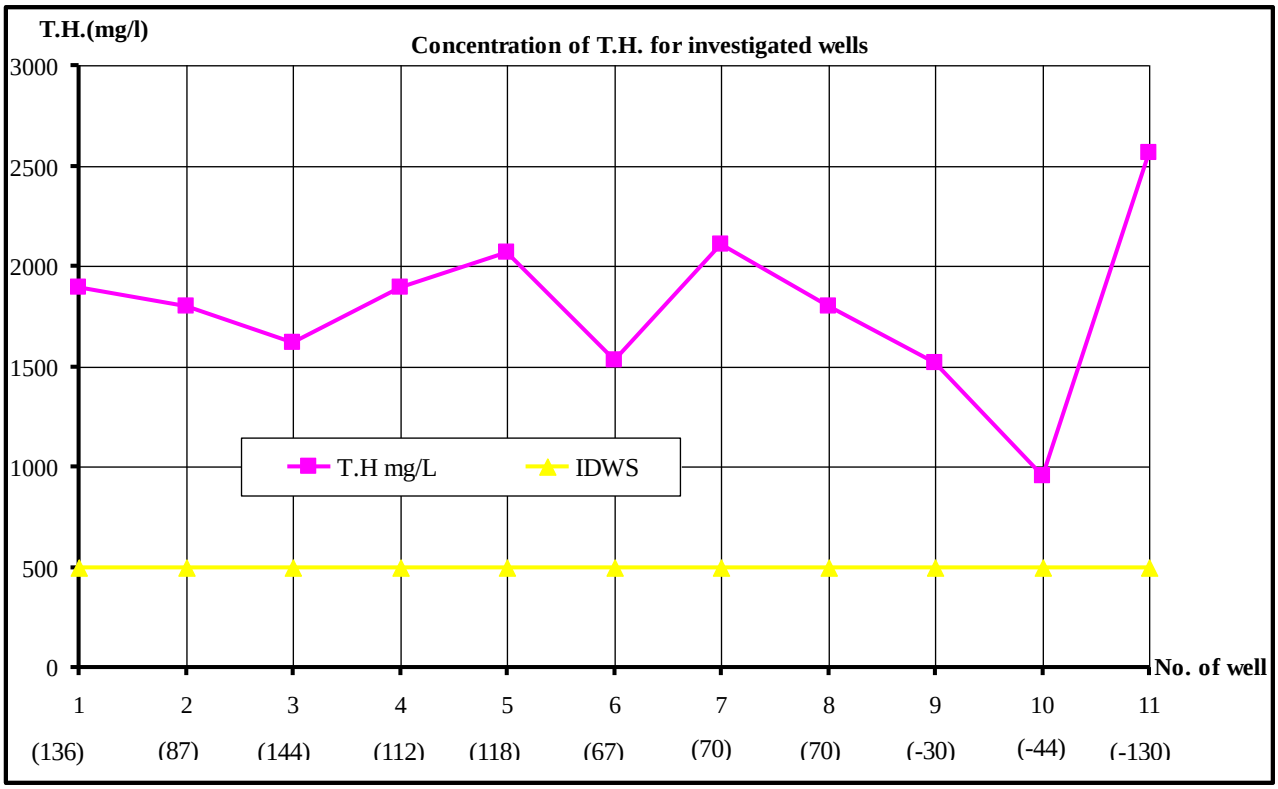

Figure (7): Concentration of T.H. and Elevation of excavation w.c.t sea level (m).

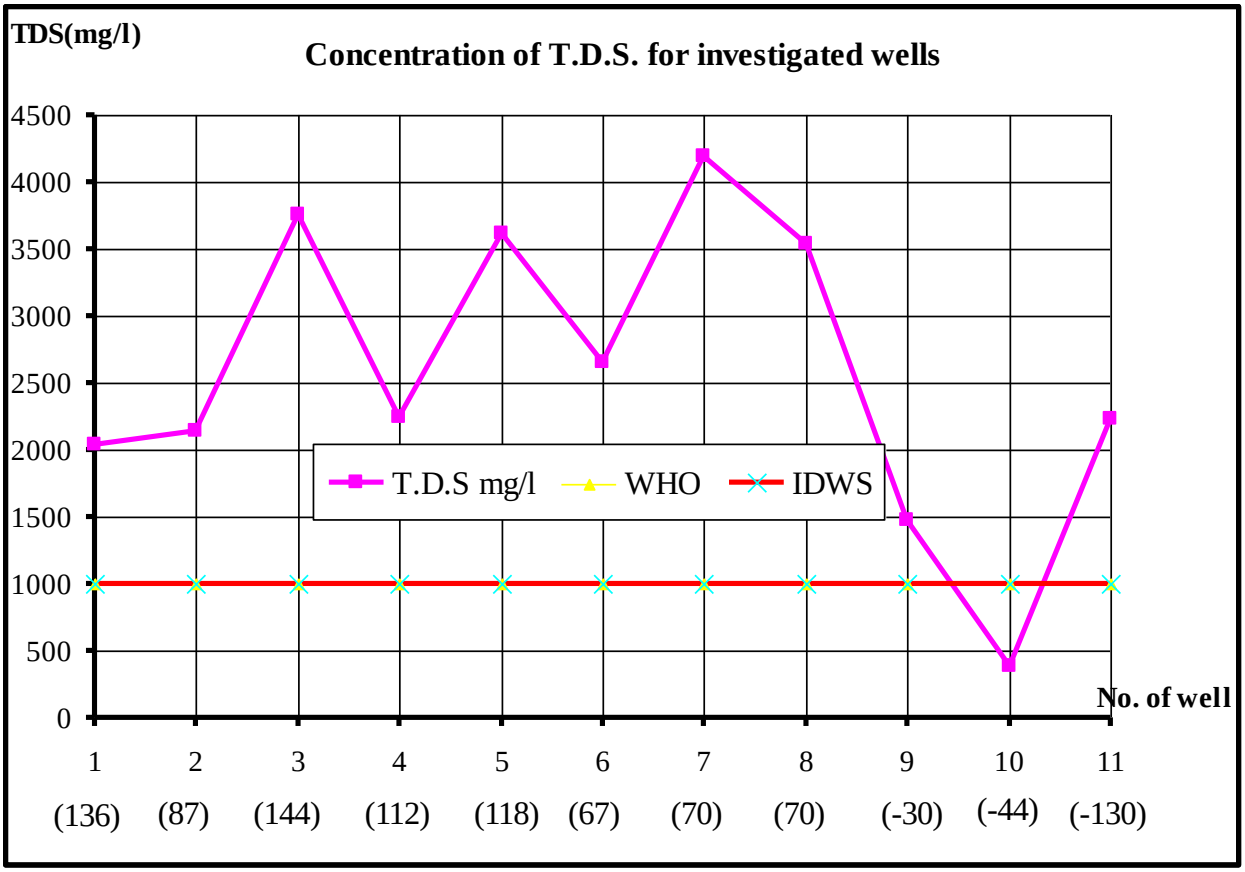

Figure (8): Concentration of T.D.S. and Elevation of excavation w.c.t sea level (m).

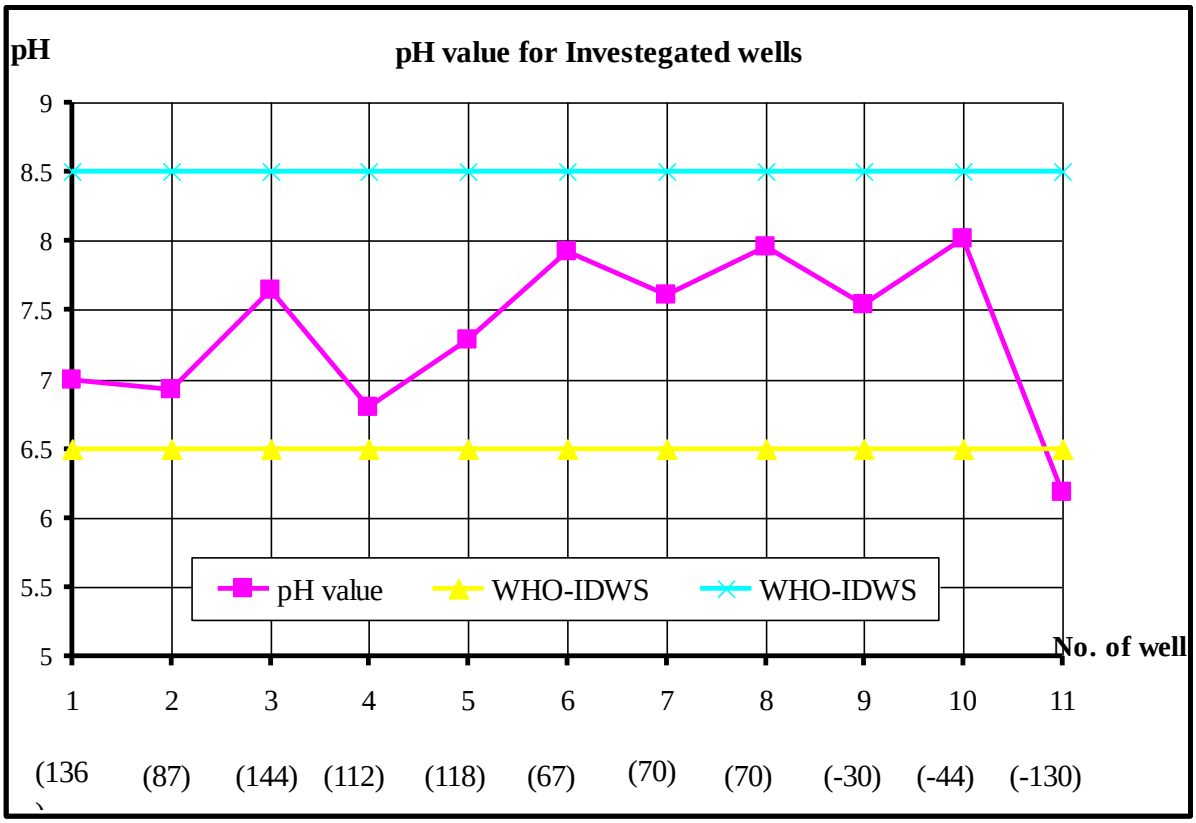

Figure (9): Value of pH and Elevation of excavation w.c.t sea level (m).

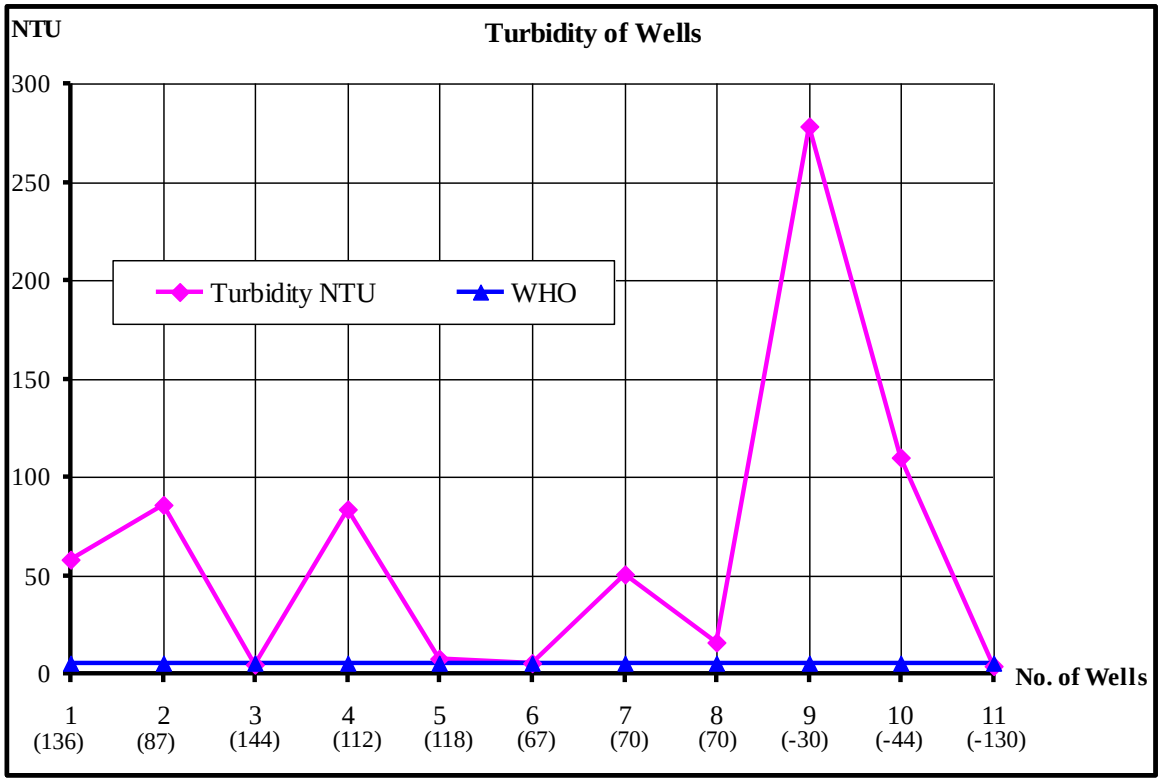

Figure (10): Value of turbidity and Elevation of excavation w.c.t sea level (m).

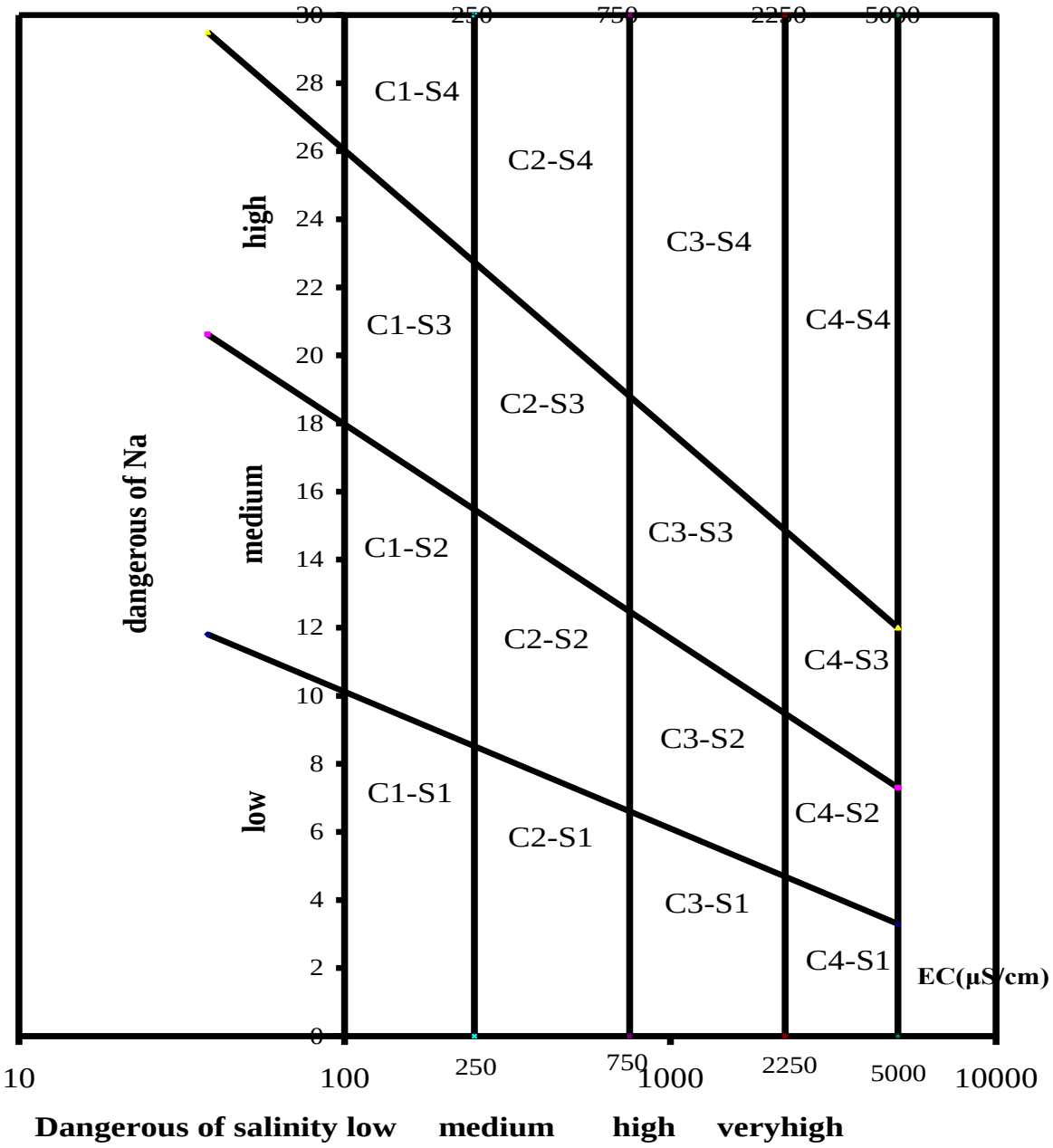

Figure (11): Classification of irrigation water according to USA salinity lab. (Lamaddalena 1997).