J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 9 (2): 93 - 101, 2018

The Reliance on some Groundwater Wells for Land Reclamation in Wadi El - Natron Region

Elbanna, E. B. ; E. E. Amin; M. I. Ghazy and A. A. Badr
Agric. Eng. Dept., Fac. Agric., Mansoura University, Egypt

ABSTRACT

The reliability on the groundwater wells in Wadi El-Natrun Region was determined in order to help in agricultural development plans for adding a new water resources and new agricultural land. Whereas, the data about the construction of 6 groundwater wells in this region, were studied analysis to focus on 6 main indicators of well production and cost of water extracting. Those indicators include the study aquifer variables as well storativity (s), ground water properties, well efficiency, transmissivity of aquifer (T) wells variables as radius of influence (R) and the hydraulic conductivity (K). In addition the total cost of pumping 1m^3 water. Based on a surveying and collecting data, statistical and mathematical analyses were conducted for identifying these data. The gained results showed the follows; the values of total dissolved solids (T.D.S) are ranging from 451 to 1000 mg l^{-1} and the pH are ranging from 6.70 to 8.22.Thus ,the extracted water found to be suitable for agricultural purposes and valid to irrigation directly without any treatments. When applying mathematical equation for groundwater flow and selection equation to calculate well variables and aquifer has to follow that equations for unconfined aquifer due to the presence surface layer of clay that leads aquifer at that region is unconfined. The average total costs of well-constructed at a depth of (200 m) and a diameter of (250mm) were estimated about 298310 LE. However, the cost of pumping 10 ^{3}m ^{3} water of the total amount water pumped by the well during the period of operation throughout his life were estimated about 28.91 L.E.

Keywords: Wadi El Natron region, ground water properties, the construction of wells

INTRODUCTION

Egypt is a country in a semi-arid region which is facing shortage in water resources, so, in the near future, groundwater will be considered a major source of water in Egypt which consider important for agriculture purposes. Regarding to Egypt currently water needs, it is estimated at 75.21 BCM/yr, while the estimated future water needs in near future, is about 86.6 BCM/yr. Agriculture consume from 77.9% equivalent to 67.5 BCM/yr, under the fastness of water resources. Comparison of available water resources and the future needs, it can be conclude that, the water situation in Egypt is very critical. Furthermore it turns out through the statistics of the Egyptian ministry of irrigation, water deficit in Egypt will reach 18 BCM/yr by 2017, and to 32 BCM/yr in year of 2030, Wagdy (2010). In the field of groundwater hydrology, major attention has been devoted to the development and application of aquifer hydraulics, but unfortunately, much less consideration is given to the well structure itself. Although substantial effort may be expended on aquifer testing and computations to quantify the groundwater with drawal, successful operation of the system may not be achieved if the well is not properly designed (Abdulaziz and Khairi, 2014). It is clearly that, groundwater utilization has been steadily increasing in Egypt for the last 20 yrs, because groundwater representing the sole source and basic in the deserts of Egypt, which represent about 95% of the total area of the country. Therefore studying the quality of wells and groundwater validity in Egypt is the important necessities El Nahry *et al*., (2010). Wadi El-Natrun (Pliocene) aquifer is a local aquifer in the Pliocene beds that rests on top of Moghra, and Wadi El-Natrun areas. The groundwater of the Pliocene aquifer varies from fresh to brackish water. The freshwater occurs in the southern and eastern portions of Wadi El-Natrun. The Pliocene aquifer is mainly fed by lateral seepage from the Delta and Moghra aquifers. It also recharges from the south by the Nile Delta water through Wadi El Farigh. The thickness of this aquifer reaches to 140 m width with a saturated thickness of 90 m. The thickness decreases from east to west and southwards of Wadi El Natrun (Abdel Baki, 1983).

The main goal of the present study is to determine the reliability on the groundwater wells in the reclamation of new agricultural land in the Wadi El-Natrun Region. Therefore, the data requrted to achieve this goal were surveyed, collected, and analyses in order to determine and estimate each of the following parameters: - 1- The quantities and properties of ground water, as well as the wells characteristics. 2- The main variables of both wells and aquifers in the studied area, (storativity, transmissivity, coefficients and hydraulic conductivity). 3- The efficiency of well discharge assoisated to well depth. 4-The proper radius of each well, that is must be taken into account when creating a neighboring well. 5- The drawdown of water levels, well efficiency, optimum discharge, and wells condition. 6- The unit cost of drilling wells and the discharge of 1m^3 of ground water.

MATERIALS AND METHODS

1. Material

1. The study area

In the present study, 6 constructed groundwater wells were chosen to survey and collect the required data. These wells were constructed and operated in the study area which is shown the location map in Fig (1).

Fig. 1. Site map of the study area.

As shown in Fig (1), the study area belongs to Wade Al Natroun Region, which covers an area of about 770 km2 .Wade Al Natroun Region lies at El Behera governorate, western of Nile Delta, Egypt and lies between Longitudes 30° 00' and 30° 33' E and Latitude 30° 20' and 30° 30' N. It parallels to (Cairo-Alex. Desert Highway) from 90 km to 110 km

2. Power operating systems of investigated wells

The 6 investigated groundwater wells are constructed, and operating in three different private farms located in the area of Al-Beheira Governorate Egypt (Wadi El-Natron). During the time of surveying and collecting the data, some these wells were operated using the diesel engine energy while, the others were operated using the solar cells energy system. However, the deduced farm name and the power operating system of the 6 investigated wells are listed in Table (1).

3. The lithology of the studied groundwater wells

According the data available from El-Diba Co. at Wadi El-Natrun, the lithology of the 6 studied groundwater wells are indicated in tables from 2 to 7.

Table 1.The deduced farm name and the power operating system of the 6 wells

No. of well	well operating farm	well power operating system
W_1	Magdy Said Salem Farm	solar cells energy system
W_2	Magdy Said Salem Farm	solar cells energy system
W_3	Abu Alaa Farm	solar cells energy system
W_4	Elbanna Farm, diesel and solar	diesel engine energy
W_5	Elbanna Farm, diesel and solar	diesel engine energy
W_6	Elbanna Farm, diesel and solar	solar cells energy system

Table 2. The lithology of the studied well No.1 (W_1)

Depth ,m; From	To	Lithological Description (from cuttings)
0	10	Clay: black, sticky
10	18	Sand: yellow, fine to medium grained, sub rounded, moderately stored.
18	25	Sand: yellow, fine to medium grained, with clay
25	40	Sand: yellow, fine to medium grained, sub rounded, moderately stored.
40	60	Sand: yellow, medium to coarse.
60	93	Sand: white, coarse sand to gravel
93	100	Sand: yellow, fine to medium grained, well stored

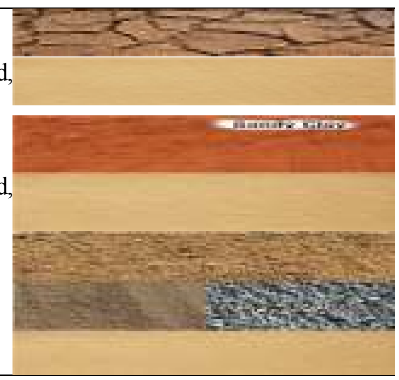

Table 3. The lithology of the studied well No.2 (W_2)

Depth ,m; From	To	Lithological description (from cuttings)
0	16	Clay: black, sticky
16	32	Sand: white to yellow, fine to medium grained, sub rounded, moderately stored, with minor clay
32	52	Sand: white to yellow, fine to medium grained, sub rounded, ill stored.
52	100	Sand: white to yellow, medium to coarse grained, sub rounded, moderately stored.

Table 4. The lithology of the studied well No3 (W_3)

Depth ,m; From	To	Lithological Description (from cuttings)
0	10	Clay: black, sticky
10	18	Sand: yellow, fine to medium grained, sub rounded, moderately stored.
18	25	Sand: yellow, fine to medium grained, with clay
25	40	Sand: yellow, fine to medium grained, sub rounded, moderately stored.
40	60	Sand: yellow, medium to coarse.
60	93	Sand: white, coarse sand to gravel
93	100	Sand: yellow, fine to medium grained, well stored

Table 5. The lithology of the studied well No.4 (W_4)

Depth ,m; From	To	Lithological description (from cuttings)
0	12	Clay: black, sticky.
12	31	Intercalation of clay and sand.
31	39	Sand: yellow, fine to medium grained, sub rounded, moderately stored.
39	53	Sand: white, medium to coarse grained, sub rounded, moderately stored.
53	100	Sand: white, very coarse to gravel

Table 6. The lithology of the studied well No5 (W_5),

Depth ,m; From	To	Lithological description (from cuttings)
0	16	Clay: black, sticky
16	32	Sand: white to yellow, fine to medium grained, sub rounded, moderately stored, with minor clay
32	52	Sand: white to yellow, fine to medium grained, sub rounded, ill stored.
52	100	Sand: white to yellow, medium to coarse grained, sub rounded, moderately stored.

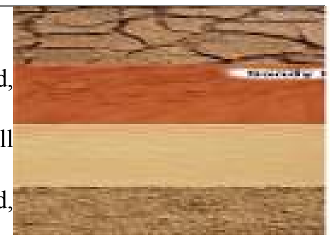

Table 7. The lithology of the studied well No6(W_6),

Depth ,m; From	To	Lithological description (from cuttings)
0	15	Clay stone. Black, sticky.
15	29	Sandstone: yellow, fine to coarse grained.
29	30	Clay stone. Black, sticky.
30	47	Sandstone: yellow, fine to coarse grained.
47	48	Clay stone. Black, sticky.
48	102	Sandstone: yellow, fine to coarse grained.

4. The process of the well construction

The process of construction the well include distinct phases which consisits of drilling, casing, well screen, well developing can perform 2-3 of these processes at the same time according to the drilling method used. When designing the discharge well must be determine the pipe screen diameters, pump casing and size gravel. These elements depend mainly on the discharge of the well also depend on each other's. There are goal of the design of the well and to avoid low efficiency during the life of the well. There are different ways to drill wells due to differences in geological nature of the soil between solid rock, granite, dolomite and sediments such as sand, gravel, and silt. In the study area certain methods of drilling is used according to the geological formation of the region because of their ability to penetrate the aquifer.

According, the commensurate well design as recommended by well drilling companies is shown in Table (8). Generally, Table (8) summarized the appropriate well designs of the investigated accordance the average depth and diameter of pipes and the quality of the dominant raw material used in the region.

Table 8. Well pipe casing, screen specifications with used raw materials.

	Average depth, m	Diameter, in	Materials used	Market types
Wells of studied area	<150	14"	Steel casing	El Nasr black
	<103	12"	Steel casing	El Nasr black
	<200	10"	Steel casing	El Nasr black
	The point of installing the pump to well head	8"	Steel pipes	In-Costeel galvanized
	At the end of each well is placed sand trap on the length of 7-12 m.			

From Table (8), it easily noticed that increasing the pipe diameter and screen diameter increase the well yield. Whereas choosing screen diameter (14") achieved the yield of (19000 m3 / day), while choosing a smaller diameter in the amount of (4') achieved the yield of (680 m3/day). It can also decided that, well yield not only affected by the diameter of the screens and pipes, but also depend on the length and number of opening on screens.

2. Methods

The present study is focused on 6 main indicators of well production and cost of water extracting for 6 groundwater wells constructed in the central, Wadi El-Natrun. Those indicators include:- 1- the extracted ground water properties, 2-the study aquifer storativity (s), 3- the well efficiency, 4- the transmissivity of aquifer (T) 5- the well radius of influence (R) and 6- the well hydraulic conductivity (K). Therefore, the experimental procedure of the present study was carried out to measure and determine the above mentioned indicators as follows:-

1. Measurements of ground water properties

Water salinity ratio is determined by analyzing water samples during drilling process and specifies concentration total dissolved solids (T.D.S). The salinity concentrations in accordance with FAO, to judge on the quality and validity of groundwater for the purpose of agriculture on the basis of ratios FAO estimated the extent of salinity and water-solids concentration. The FAO guidelines for irrigation water quality are tabulated in Table (8) in the previous section.

2. Determination the well storativity (s)

The storativity for wells in the present study was calculated according to Jacob (1947) as follows:

$$S = s_y + [2\, L_s\, (\rho_w\, g\, (\alpha + \beta\, \eta))]$$

Where

S = storativity, dim;
b = aquifer thickness, m;
ρ_w = density of water, kg/m^3;
g = acceleration of gravity, m/sec ^{2};
α = compressibility of the aquifer skeleton, m^2/N;
η= porosity, dim;
β= compressibility of water, m^2/N;
L_s = is length of screens in well, m;
Sy = specific yield, dim.

The values of the well loss using analysis of step drawdown test were estimated. Hence, the total drawdown (s_w) at the well may be rewritten for the steady-state confined case by Jacob (1947) as follows:

$$s_w = \frac{Q}{2\pi T}\, In\left(\frac{R}{r_w}\right) + CQ^n$$

Where

s_w= is drawdown, m;
Q = well discharge rate, m^3/day;
R = is radius of influence of the pumping well, m;
T = is transmissivity, m^2/day;
r_w, = is radius of the well, m.
C= well loss coefficient, day^2 m^{-5}.

The above equation may be simplified such as:

$$B = \frac{In\,(R/r_w)}{2\pi T} \text{ so that: } s_w = BQ + CQ^n$$

Where

s_w= is drawdown, m;
Q = well discharge rate, m^3/day;
R = is radius of influence of the pumping well, m;
T = is transmissivity, m^2/day;
r_w, = is radius of the well, m.
C= well loss coefficient, day^2 m^{-5}.
B = aquifer loss coefficient, day m^{-2}.

3. Determination the well efficiency (Ew)

The above mentioned values of (B, C) could be found using by curve-fitting or by using statistical analysis. Many researchers [Labadie and Helweg (1975) and Gupta (1989)], suggested that the constant (n) could be assumed as (n = 2). Consequentially, the well efficiency (E_w) could be determined according to Bierschenk (1998), who was defined that, is the ration between theoretical drawdown and the actual drawdown, and may be calculated as follows;

$$E_w = \left(\frac{Q/s_w}{Q/BQ}\right) \times 100 \qquad \text{or} \qquad E_w = \left(\frac{BQ}{s_w}\right) \times 100$$

Where

B = aquifer loss coefficient, day m^{-2}.
C = well loss coefficient, day^2 m^{-5}.
E_W = well efficiency;
Q = well discharge rate, m^3/day;
Sw= is drawdown, m.

4. Determination the aquifer transmissivity (T)

The transmissivity of the aquifer could be determined according to, Driscoll (1986) as follows:

$$T = \frac{1.22\, Q}{s'}$$

Where

T = is transmissivity, m^2/day;
s' = is the corrected drawdown, m;
Q = well discharge rate, m^3/day.

The corrected drawdown (s') could be calculated as follows:

$$s' = s_w - \frac{s_w^2}{2b}$$

Where

s' = is the corrected drawdown, m;
b = aquifer thickness, m;
s_w= is drawdown, m.

The values of the well loss using analysis of step drawdown test were estimated. Hence, the total drawdown (s_w) at the well may be rewritten for the steady-state confined case by Jacob (1947) as follows:

$$Sw = \frac{Q}{2\pi T}\, In\left(\frac{R}{r_w}\right) + CQ^n$$

Where

s_w= is drawdown, m;
Q = well discharge rate, m^3/day;
R = is radius of influence of the pumping well, m;
T = is transmissivity, m^2/day;
r_w, = is radius of the well, m.
C= well loss coefficient, day^2 m^{-5}.

5. Determination the radius of influence of well (R)

When creating a neighboring well in any region, it should be takes into account the value of influence radius between wells. That is done to avoid overlap between them, and also to avoid the increment of drawdown water level in neighboring wells. The radius of influence of well could be calculated according to, Shata,(1983) as follows:

$$R = \sqrt{2.25\, T\, \frac{t}{s}}$$

Where

R = is radius of influence of the pumping well, m;
T = is transmissivity, m^2/day;
S = storativity, dim;
t = is the period of measurement, day.

6. Determination the hydraulic conductivity coefficient (K)

To determine the value of hydraulic conductivity is of great importance because this coefficient largely controls the amount of water leaked from and to the aquifer. The hydraulic conductivity could be calculated according to Shata,(1983) as follows:

$$Q = \frac{2.73}{2} K \left[\frac{h_2^2 - h_1^2}{\log\left(\frac{R}{r_w}\right)} \right]$$

Where

Q = well discharge rate, m^3/day;
K = The hydraulic conductivity, m/day;
R = is radius of influence of the pumping well, m;
h_2 = is level static for water in well, m;.
h_1 = is level dynamic for water in well, m;
r_w, = is radius of the well, m.

The above equation could be rewritten to simplify in unconfined aquifer calculations as follows:

$$K = \frac{Q}{\frac{2.73}{2}(h_2^2 - h_1^2)} \log\left(\frac{R}{r_w}\right)$$

Where

Q = well discharge rate, m^3/day;
K = the hydraulic conductivity, m/day;
R = is radius of influence of the pumping well, m;
h_2 = is level static for water in well, m;.
h_1 = is level dynamic for water in well, m;
r_w, = is radius of the well, m.

7. Determination the cost of water extracting from well.

Groundwater costs are divided into well construction costs and water pumping costs. Generally, to determine the total well costs it is necessary to identify the following well criteria such as well location, well depth, well diameter, the raw materials that will be used, and the purpose of the well. However, the well construction costs included the following items as;

1. Costs of monitoring the location.
2. Cost of drilling the well.
3. Cost of well pipes and screens.
4. Cost of finishing the well.
5. Costs of installation the well and pump.

While, the water pumping costs included the following items as;

1. Cost of electrical works.
2. Cost of different pumps.
3. Cost of conduct pumping tests and development of the well.

The data collected about well construction costs, were obtained from drilling companies in Cairo such as; (Co. Regwa - Co. Arabia - Co. Egyptian drilling). While the data collected about well pipes costs were obtained from drilling from supplying and distributing companies such as; (Co. the Egyptian union for commerce- Co. Aqua group - special exhibitions in Al-Sabtiah street).At the same time, the data collected about costs of different pumps, power cables and generators were done from companies in El Gomhareya street in Cairo such as (Co. Ramsess - Co. Ahmed Daoud — Co. Omega Egypt).

RESULTS AND DISCUSSION

1. Identification the studied ground water properties

Table (9) summarizes the studied ground water properties that collected during the research period in Wadi El Natrun area from the 6 investigated wells. These properties include static water level (S.W.L), total dissolved solids (T.D.S) and pH. For each investigated well.

It can be noticed that, from Table (9) that the maximum T.D.S value was accomplished to well No W_3 (about 1000 mg l^{-1}).While the minimum T.D.S value was accomplished well No. W_4 (it was about 451 mg l^{-1}). Regarding the pH degrees, it was found that those degrees are ranging from 6.70 to 8.22. From theses mentioned values it can be judged that the extracting water are to be normal. Moreover it can be decided that, all T.D.S and pH values located in the surveys limits for use in irrigation water according to the FAO. Therefore we can use the groundwater of the study area in the reclamation of new land directly without any treatment. Thus, we can drill any wells in those areas for the purpose of agricultural reclamation without fear of water salinity.

Table 9. the studied ground water properties

Well NO	pH	T.D.S, mg/l	S.W.L,m	Depth of borehole, m
W1	7.70	499	7.30	105
W2	7.70	499	7.19	103
W3	7.60	1000	5.10	100
W4	6.95	451	5.60	100
W5	6.70	555	7.75	103
W_6	8.22	826	6.05	102

2. Identification operation characteristics of the studied wells

Figs from 2 to 7 are indicating the measured data about the operation characteristics of the studied groundwater wells. These characteristics are represented in the water level at various discharge and three periodic times of 0, 30, 60, and 120 minutes for each investigated wells.

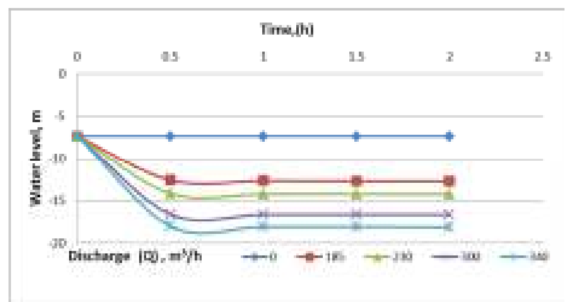

Fig. 2. Operation characteristics of Well (NO. 1) (Note: static water level was 7.30 m)

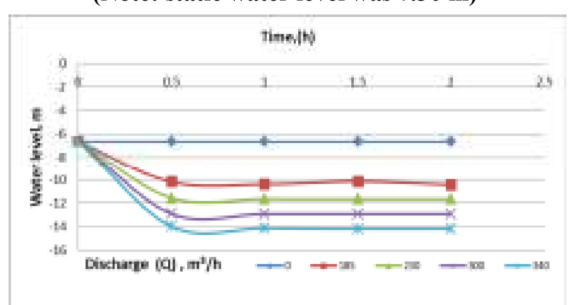

Fig. 3. Operation characteristics of Well (NO. 2) (note : static water level was 6.65 m)

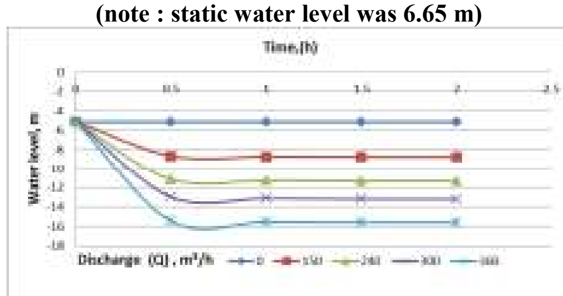

Fig. 4. Operation characteristics of Well (NO. 3) (note : static water level was 5.10 m)

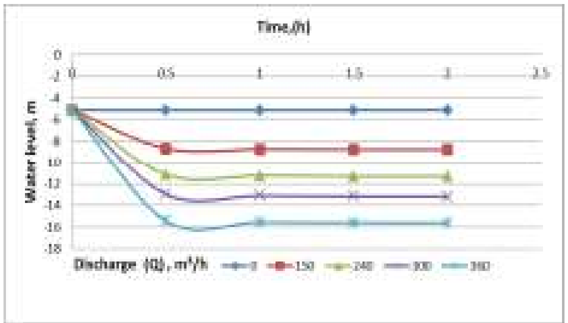

Fig. 5. Operation characteristics of Well (NO. 4) (note : static water level was 6.30 m)

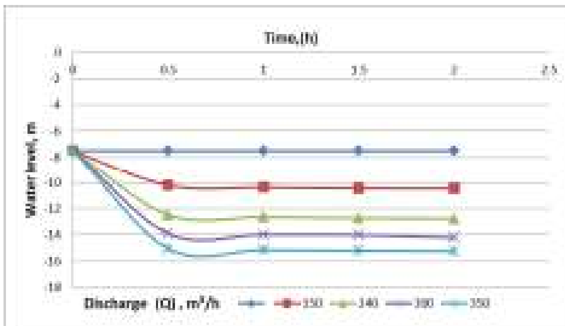

Fig. 6. Operation characteristics of Well (NO. 5) (note : static water level was 7.50 m)

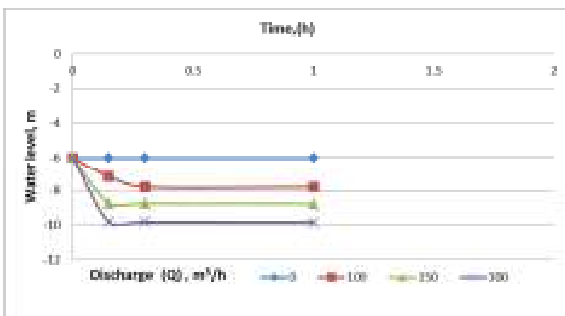

Fig. 6. Operation characteristics of Well (NO. 1) (note : static water level was 6.05 m)

The advantage of the above shown data in Figs from 2 to 7 is to calculate the well efficiency and determine the optimal discharge of each well, as well as the status of the well design.

However, it is clear that these data, it include independent variables for each well such as the static water level (S.W.L) (h_1), pumping time (t), the discharge (Q) and the dynamic level (h_2). In addition, these data have been calculated value drawdown water level inside the well (s_w) during periods of pumping by finding the difference between dynamic and static water level. With regard to the value of drawdown note that, at the beginning of the pumping time increases the value of drawdown at a high rate, then less that rate to prove that at a certain time and continues steadfast until the end of pumping. it can be noticed that, the maximum drawdown value was accomplished for well No.W_1 about 10.8m at the discharge 340 m^3/hr. while the minimum drawdown value was accomplished for well No, W_6 about 3.81 m at the discharge 200 m^3/hr.

In addition, increasing the rate of discharge increased the value of drawdown water level in the well. At the same time noticed the data shows the effect of increasing the discharge on the value of drawdown during step pumping test for well No W6. These data represent 3 different stages for the discharge of the pump (100-150-200 m3/hr), for 60 min during the pumping and 4 different stages for the discharge of the pump, for 60 min during the pumping for all wells except well No W6.

3. Evaluation the well storativity(S)

The estimated values of the well storativity (S) were calculated according to Jacob (1947) for each investigated wells, and tabulated in table (10) together with all of the equation variables.

It should be denoted that the variables of the equation (s_y, α, η) could be determined using Todd and Mays (2004) . It is clearly noticed that, the average storativity values in general for studied area was 0.32. The above result trend may be attributed to, the aquifers in this area which is unconfined aquifers, this result trend is in agreement with the reported data by (Lohman,1972), who found that, the storativity of unconfined aquifers, were varied with specific storage and aquifer thickness, and its typically ranged from 0.1 to 0.3.

It is also noticed that, there is an overlap between these values is due to the overlap size distribution of the granules. By comparing those values of the geological formations for aquifers, found that the highest value of the sand, while the less valuable to clay. The movement of water increases in coarse grained, such as gravel. Therefore the well screens designed in this sector, due to facilitate the movement of water from the pores of coarse rock.

4. Identification the well efficiency (Ew)

As indicated befit should be noticed that before estimating the well efficiency (Ew), it should be determine both aquifer loss coefficient (B),and well loss coefficient (C) .these coefficients were estimated using statically analysis by program STATS (version 2). Table (11) shows the downward regression analysis (Coefficients and their standers errors with degree of explanations for various investigated wells.

Consequently, the estimated values of the well efficiency (Ew) were calculated according to Bierschenk (1998), for each investigated wells, and tabulated in table (12) together with all of the equation variables.

It is clearly noticed that, the data in Table (12) that, the most of those efficiencies were greater than 65%. The above result trend may be attributed to those values as acceptable, because it is more than 70%. This results trend is in agreement with the reported data by Kasenow (2001) who found that, a well efficiency of 70% or more is usually acceptable. If a newly developed well has less than 70% efficiency, it should not be accepted. While the value were less than 70% in the well No W_5, any significant decline in the specific capacity of a well can be attributed either to reduction in transmissivity due to a lowering of the ground water level in an unconfined aquifer or to an increases in well loss associated with closing or deterioration of the well screen.

Table 10. The estimated storativity values

Well No	specific yield		storativity,	length of screens in well,	aquifer thickness	compressibility of the aquifer skeleton	compressibility of water	porosity
	Sy, dim	Sf, m^{-1}	S, dim	LS, m	b, m	α , m2/N	β, m^2/N	η, dim
W1	0.32	0.001	0.32478	24	48	10-8	4.4*10-10	0.32
W2	0.32	0.001	0.32478	24	48	10-8	4.4*10-10	0.32
W3	0.32	0.001	0.32478	24	48	10-8	4.4*10-10	0.32
W4	0.32	0.001	0.32478	24	48	10-8	4.4*10-10	0.32
W5	0.32	0.001	0.32478	24	48	10-8	4.4*10-10	0.32
W6	0.32	0.001	0.32478	24	48	10-8	4.4*10-10	0.32

Table 11. Downward regression analysis (Coefficients and their standers errors with degree of explanations for the various investigated wells

Well NO	Coefficients		Standard errors		T-test			
	B*10-2	C*10-5	B*10-4	C*10-6	B	C	R2,%	DF
W1	2.50	1.82	3.71	1.26	67.55	14.46	99.95	93
W2	1.59	1.49	3.95	1.32	40.25	11.29	99.89	93
W3	1.79	2.75	9.85	3.19	18.25	8.61	99.46	93
W4	1.27	1.80	1.77	5.86	72.02	30.70	99.97	94
W5	1.33	2.34	5.01	1.68	26.56	13.86	99.80	93
W6	1.54	1.70	1.35	7.81	113.98	21.85	99.99	58

Table 12. the efficiency and the optimum discharge and designed condition for each well

Well No	Q, m3/h	K, m/s	SWL, M	DWL, M	Ew , %	Well Hole,m	DRD, n
W1	263.75	7.45260	7.30	15.129	83.36	0.055	7.82
W2	266.73	13.4689	6.65	12.013	79.67	0.055	5.36
W3	261.47	11.9451	5.10	11.873	71.69	0.055	6.75
W4	256.35	12.8257	6.30	10.868	73.07	0.055	4.56
W5	253.47	8.96470	7.75	12.760	69.80	0.055	5.00
W6	146.66	10.3420	6.05	8.7170	84.78	0.055	2.66

5. Identification the transmissivity, influence radius of, and the hydraulic conductivity

The estimated reliability indicators values (T, R and K) are estimated and determined are shown in Table (13). However, the estimated values of the transmissivity (T) were calculated according to Driscoll (1986) for each investigated wells. While the influence radius (R) of each pumping wells from W_1 to W_6 were calculated according to Shata, (1983) and shown also in table (13).

In addition, the estimated values of the hydraulic conductivity (K) were calculated according to Shata, (1983) and shown also in table (13).

Table 13. The estimated reliability indicators values (T, R and K)

Well No	Transmissivity	Influence radius of the well	Hydraulic conductivity
	T,(m^2/day)	R,(m)	K,(m/s)
W1	1059.51	42.123	7.45260
W2	1551.72	51.063	13.4689
W3	1254.02	45.910	11.9451
W4	1757.96	54.218	12.8257
W5	1617.08	52.061	8.96470
W6	1652.9	71.507	10.3420

It can be noticed form table (13) that, the Transmissivity values in the study area are ranging between 1060-1758 (m^2/day)

It can be noticed form table (13) that, the maximum Influence radius value (R) in the study area was accomplished the well No.W_6 which was about 72 m, While, the minimum (R) value was accomplished the wells No. W_1, which was about 42 m

It is also noticed that, the hydraulic conductivity values for wells in the study area are ranging between 7.45 - 13.47m/s.

6. Identification the cost of Drilling and discharge.

The estimation of all cost items required to determine the cost of drilling and discharge of all the investigated 6 ground water wells under study, were carried as indicated in the methodology as follows:.

1. Estimation costs of monitoring the location

Considering that the monitoring can conceived for the optimal design of the well. hence the costs of monitoring 1m depth of no more than 70 L.E. Sometimes it turns out there are cameras perform that operation at a cost 50 LE.

2. Estimate the costs of drilling the well

Regarding to the cost of well per 1m depthit can be found that these costs are different according to the different location, and type of drilling (percussion or hydraulic rotary), as well as well diameter and the purpose of its use. However, the cost of drilling for 1m depth with different diameter for studied area is tabulated in Table (14). It can be noticed that, the drilling (digging) cost for any located area using methods of hydraulic rotary is greater than percussion method.

Table 14. Costs of well drilling per 1 m depth with difference diameter

Drilling type	Cost of 1m depth drilling at various diameter	
	Drilling diameter, in	Cost, L.E.
Percussion	8-14	300-350
Hydraulic rotary	14-20	370-460
Hydraulic rotary	20-24	500-4800

3. Estimate the pumps costs

The pump costs include the prices of submersible and centrifugal pumps. To evaluate those element costs, it is required to determine operating parameters such as static and dynamic water head, pipe diameter and the actual discharge. Generally, it can be concluded that the static water level in the Delta region does not exceed 5 to 8 m, therefore a centrifugal pump was fitted on the well head. From surveying data, most farm used the lowara, Italy pump with a 17,000 to 20,000 LE. While, in Wadi El-Natrun area, it was observed that the static water level away from the ground surface more than 80 m and required to use submersible pump in this region. With often pump used of stainless steel, Ovel, Turkish. It gives a manometric head to 460 m with discharge of 200 m^3/hr. Found in the Egyptian markets that, the pump contains the number of stages and different capacity. The number of based on head manometric required and discharge required from the well. it contains those pump prices based on the number of stages and different horsepower (HP).

4. Estimate the costs of electrical works

These costs consist of the generator costs, of electrical control panel and power cable that runs from the pump to installation point to electrical control panel. Regarding, kilowatt-hours which have been identified in the Table (13), the purpose for determining the power of generator is required to run those pumps. At the same time, it must be add additional load to carry out the pump when determining the capacity of the generator. Generally, it was found that, the average prices of generators that run these pumps ranging from 75,000 to 90,000 LE. Furthermore, the cost of collection and installation of the electrical control panel was evaluated by 4000 LE. On the other hand, the cost of the cable generally averaged by 20 to 25 / LE / 1m height of the well.

5. Estimate the costs of finishing the well

The finishing costs, included the placed gravel around the screen and pipes, the constructed its head, cleaning, developing, pumping tests, installation the pipes and other costs, as shown in Table (15).

6. Estimate the total well construction costs

Data of the total costs for the construction of wells were estimated based on monitoring the location, drilling well, pipes well, screens well, different pumps, finishing the well and electrical works. Estimated total costs for the construction of wells in Table (16) for both studied regions. Those data represent 2 diameters and various depths. From Table (11), it can be seen that, the cost of construction in well at Wadi El-Natrun region is high .At the same time it can be noticed that, increasing the depth of well at the same diameter and region , increased the total costs of construction well. Whereas, increased the costs to Wadi El-Natrun wells from 213,820 to 377,220 LE.

Table 15. Costs of finishing the well

Process	Cost, LE.
Supply the gravel packed around screens, per 1m.	260-300
Concrete around the well head,per1m.	200
Cleansing the well using air compressor.	20,000-25,000
Development of the well by various pumping rates.	20,000-30,000
Pumping tests.	8,000-12,000
Installation the pipes.	6,000
Other costs.	5,000

Table 16. Total costs of construction wells

Well depth, m	Pipe diameter , in	Average total costs of well construction at various depth and 2 standard diameter, LE.
100	10	213,820
	16	237,280
200	10	298,310
	16	332,900
300	10	377,220
	16	450,766

7. Solar cells energy system cost:

In the present time, all Wadi El-Natrun farms or farmers tend to use the Solar cells energy station to drive their submersible pumps alternatively the disel system after the price of disel was highly raised up. The total cost of constructed solar energy station was 14,000 to 15.000 LE / 1 KW as a source of operate their submersible pumps. That it is means they set their stations 1 KW to operate 1 hp and the fraction of the KW (0.34HP) to overlap the friction of the well system (e.g. if you have 10 hp submersible pumps, you need a 10 KW solar energy.

Table 17. The cost of pumping 1000 m^3 water .

Well depth, m	Pipe diameter, in	Cost of pumping 103m3 water, LE/ 1m3.
100	10	23.01
	16	25.4
200	10	27.01
	16	28.91
300	10	30.3
	16	31.2

8. Estimation costs of pumping 103 m3 water

With regard to calculate the cost of pumping 10^3 m^3/h water were estimated based on assuming the well has been working for 12 hr a day and average operating life of almost 20 years ago. By knowing the amount of pumping well in hours, can be calculated on the length of his life, and by dividing the total cost of the well on the total amount of water that will be pumped from the well, conclude that the cost of 10^3 m^3 water. The cost of pumping 10^3 m^3 water, of the total amount of water pumped by the well during the period of operation throughout his life are tabulated in Table (17).

CONCLUSION

From the gained result it can be concluded that, the ground water wells which have been constructed in Wadi El Natrun region are valid to rely in reclamation of new agricultural land and valid to used in irrigation directly without any treatments. The need for the development of the well after 10 years of operation is required, in order to raise its efficiency again.

REFERENCES

Abdel Baki, A.A. (1983). Hydrogeological and hydrogeochemical studies on the area west of Rosetta branch and south El Nasr Canal. Ph. D. thesis, Fac. Sci., Ain Shams Univ., Egypt: 156.

Abdulaziz;A.M and M.L. Khairi (2014)Study the effect of certain industrial pollutant sand bacterial groundwater area Tajura .International Journal for Environment & Global Climate Change.2(4):123-136.

Ayres, R.S. and D.W.Westcot. (1985). Water quality for agriculture.UN-FAO Irrigation and Drainage. Rome., Italy:29.

Bierschenk,W.H. (1998). Determining well efficiency by multiple step drawdown. J. Assoc. Sci. Hydrology., publ.64:493-507.

British Standards Institution. (2003). Hydrometric determination pumping tests for water wells-considerations and guidelines for design, performance and use. British Standards., BS ISO 14686.

Driscoll, F.G.(1986). Groundwater and wells. 2nd edition., Johnson Filtration Systems, Inc., St. Paul., USA.

El-Abd, E.,(2005). The Geological impact on the water bearing formations in the area south west Nile Delta, Egypt (Ph.D. Thesis). Geol. Depart. Fac. Sci., Menoufia Univ., p. 319.

El Nahry A. H; H.H. Elewa and A.A.Qaddah (2010). Soil and Groundwater Capability of East Oweinat Area, Western Desert, Egypt Using GIS Spatial Modeling Techniques. Nature and Science.8:8

El Shazly,E.M; M.A. Abdel Hady; M.A. El Ghawaby; I.A. El-Kassas; A.A. El Fadlelmawla and M.A. Dawoud.(2006). An approach for delineating drinking water wellhead protection areas at the Nile Delta. J. Environmental management., Egypt. 79:140-149.

FAO. (1985). Water Quality for Agriculture.Ayers, R.S.and D.V. Westcot. Irrigation and drainage paper 26. Food and Agriculture Organization for the United Nations, Rome revised .

Ferris, J.G; D.B. knowless; R.H. Brown and R.W. Stallman. (1962). Theory of aquifer tests. U.S. Geological Survey. Water-supply. Paper, 1536E:174.

Gadlelmawla, A.A. and M.A. Dawoud.(2007). An approach for delineating drinking water wellhead protection areas at the Nile Delta. J. Environmental management., Research institute for groundwater.

Gupta, A.D.(1989). On analysis of step-drawdown data. J. ground water. 27(6): 874-881.

Jacob,C.E.(1947). Drawdown test to determine effective radius of artesian well. American Society of Civil Engineer. 112:1047-1070.

Kasenow, M.(2001). Applied ground water hydrology and well hydraulics. Text book., Water Resources publications. 2nd edition: 638-642.

Labadie, J.W. and O.J. Helweg. (1975). Step-drawdown test analysis by computer. J. ground water. 13(5): 46-52.

Lohman, S.w. (1972). Ground-water hydraulics. U.S. Geological Prof. Paper708:70.

Shata, A.A. (1983): “New light on structural development of Western Desert of Egypt”. Bull. Inst. Desert d'Egypt, T.3, No.1, pp. 101-106.

Thiem, G.A. (1906). Hydrologische methoden. Gebhardt, Leipzig., Germany.

Todd, D.K. and L.W. Mays. (2004) .Groundwater hydrology. 3rd edition., John Wiley & Sons, Inc., USA.

Wagdy, A.(2010). Progress in water resources management: Egypt. Proceedings of the 1st technical meeting of Muslim water researchers cooperation (MUW AREC), project director. Professor of hydraulics, engineering, Cairo univ., Egypt.

Walton, W.C.(1962). Yields of deep sandstone wells in northern Illinois. Rept. Illinois state water survey., Urbana. 43:47-50.

درجة الاعتمادية على بعض آبار المياه الجوفية لاستصلاح الأراضي في منطقة وادي النطرون

الشحات بركات البنا ، عماد الدين أمين عبد الله ، محمد ابراهيم غازي وعلي أمحمد بدر
قسم الهندسة الزراعية، كلية الزراعة، جامعة المنصورة

نظرا للاحتياجات المستقبلية لموارد مائية جديدة في مصر كي تساعد في خطط التنمية الزراعية لاستصلاح أراضي جديدة لكي تضاف إلي الرقعة الزراعية الحالية. لذلك نفذ هذا البحث لدراسة مدي إمكانية الاعتماد علي بعض ابار المياه الجوفية المشيدة بمنطقه وادي النطرون .حيث تم دراسة البيانات المتعلقة ببناء وتشغيل وانتاج ٦ أبار بمنطقه وادي النطرون مع التركيز علي مؤشرات رئيسيه لإنتاج البئر وتكلفه استخراج المياه منه وهذه المؤشرات هي معامل التخزين (S) ، خصائص المياه الجوفية،كفاءة البئر ،قدره السماحية (T) ، نصف قطر دائرة تأثير البئر(R) ،معامل لتوصيل الهيدروليكي (K) بالإضافة للتكلفة الكلية لضخ ١م^3 مياه .تم عمل تحليل رياضي وإحصائي للبيانات المجمعة. وكشفت النتائج المكتسبة علي ما يلي :تركيز الأملاح الكلية الذائبة بتلك المياه تتراوح من ٤٥١ إلي ١٠٠٠ملجرام/لتر ورقم الحموضة يتراوح من ٦.٧ الي ٨.٢٢ لذلك تعتبر المياه المستخرجة صالحه للأغراض الزراعية والري مباشرة دون أي معاملات .عند تطبيق المعادلات الرياضية لتدفق لمياه الجوفية تتبع معادلات الخزان الجوفي الغير محصور .شملت التكلفة الإجمالية لاستخراج المياه من البئر العناصر التالية (مراقبه الموقع- حفر الآبار).قدر متوسط التكلفة الإجمالية للبناء علي عمق ٢٠٠ م وقطر ٢٥٠ متر ب٢٩٨.٣١٠ جنيها ومع ذلك فان تكلفه ضخ ١٥٠٠ م^3 مياه من إجمالي كميه المياه التي تم ضخها خلال فتره التشغيل طوال عمره قدرت بحوالى ٢٨.٩٢ جنيها مصريا.