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# EVALUATION OF HYDRAULIC PARAMETERS FOR DARA AREA (GULF OF SUEZ), EGYPT

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## ABSTRACT

This work aims to furnish a basis for evaluating the water resources in Dara Area which is one of the vergin areas assigned for the purpose of land reclamation. Analysis of pumping and recovery tests performed in the study area is done by six methods manually and three methods using computer program. The data obtained by both methods show close similarity, and accordingly, the computer programs used are recommended for future analysis.

The results show that the aquifer in the area is of the semiconfined type and is dissected by several barriers (faults) which were not identified by current methods of investigation. The weighted average values of the hydraulic parameters furnish reliable bases for further investigation and computation of groundwater potentialities within the study area using the relevant computer simulation programs.

## INTRODUCTION

Wadi Dara is located at a distance of about 45 Km southwest Ras Gharib on the western side of the Gulf of Suez. This wadi is bordered from north, by Wadi Shagar, from south by Esh El Mellaha Range while from east and west directions, it is bounded by the Gulf of Suez and the Red Sea Hills respectively (Fig. 1).

The water-bearing formations in the study area consist mainly of sedimentary successions overlying the Precambrian basement complex. These successions include sandstone (fine to coarse), limestone overlained by evaporite, gravel and Wadi alluvium. Such formations are intercalated with clays and shales which give the whole formation the semiconfined condition.

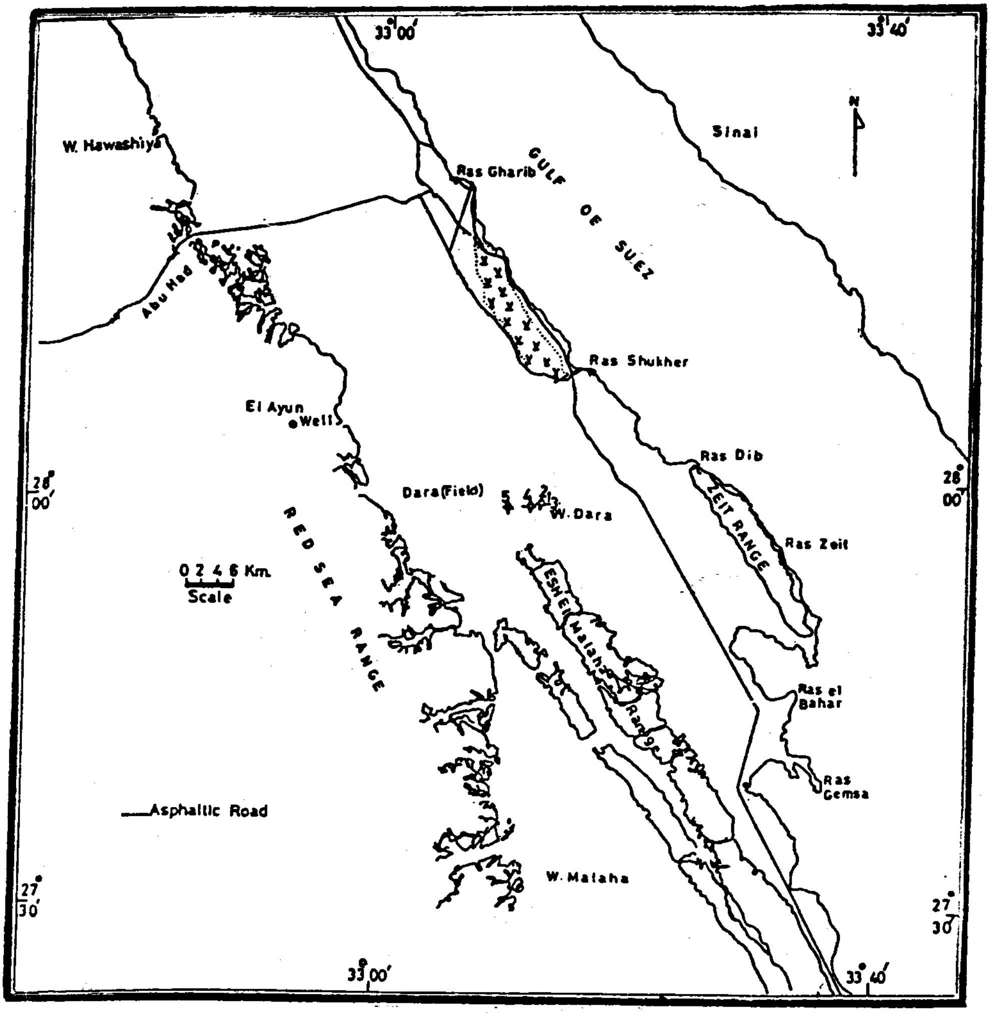



Fig. 1. Well Location Map

## DATA USED

Evaluation of the hydraulic parameters is done through analysis of pumping and recovery tests carried out by Desert Research Institute for the main water-bearing formation (the Pre-Miocene Sandstone). The hydraulic parameters include:

Transmessivity (T).

Storage coefficient (S).

During execution of mineral, Petroleum and Groundwater Assessment Program (MPGAP), three groups of pumped and observation wells were especially drilled by the Desert Research Institute within the study area (1987) for performing the pumping and recovery tests.

The three groups of wells are:

— DARA-3 (Production) and DARA-2 as a piezometer.
— DARA-4 (Production) and DARA-4 (Observation) as a piezometer.
— DARA-5 (Production) and DARA-5 (Observation) as a piezometer.

The mentioned groups of wells are partially penetrating the whole aquifer which is considered as of semiconfined to confined type.

The location of the pumped wells and observation piezometers are shown in Fig. 1. The specification of wells and piezometers are tabulated in Table 1.

**Table 1**
Design of wells in Dara Area

| Well No. | Drilling depth (m) | Length of casing (m) | Length of filter (m) | Depth to water (m) | Saturated thickness of aquifer (m) |
|---|---|---|---|---|---|
| DARA 3 PR | 221 | 173 | 43 | Flowing | 56 |
| DARA 2 OB | 212 | 137 | 55 | Flowing | 60 |
| DARA 4 PR | 230 | 100 | 100 | 19.00 | 280 |
| DARA 4 OB | 156 | 110 | 40 | 19.40 | 136 |
| DARA 5 PR | 184 | 86 | | 41.46 | 142 |
| DARA 5 OB | 80 | 60 | 10 | 43.295 | |

A single test was carried out for the first and third group of wells (DARA2 OB1 and DARA5 OB1) while two tests were done for the second group (DARA4 OB1 and DARA4 OB2).

## METHOD OF ANALYSIS

Five methods are applied for analysis of pumping test data and one method for analysis of recovery test data. Beside these manual methods, relevant computer programs were applied for analysis of the same data by three methods. A comparison between the manual and computer methods of analysis is performed.

The five manual methods applied for pumping test analysis are:

1) Hantush's modification of the Theis method for partial penetration.
2) Hantush's modification of the Jacob method for partial penetration.
3) Theis matching method.
4) Chow's method.
5) Jacob straight line method.

The three methods applied using computer programs are:

1) Theis matching method.
2) Theis Fit method.
3) Straight line approximation method (for plotting and evaluation of pumping and recovery test data).

## MANUAL ANALYSIS OF PUMPING AND RECOVERY TEST DATA

The approximate solution for the nonequilibrium equation developed by Theis and others consider that the pumped well penetrates the entire aquifer. However, the pumped wells in Dara Area are partially penetrating the aquifer. For this reason the modifications made by Hantush (1962) for both Theis and Jacob methods for partial penetration, (confined or unconfined aquifers) would be applied.

(1) Hantush's Modification of the Theis Method for Partial Penetration: According to Hantush (1962), the drawdown in a piezometer for short period of pumping is given by the following equation.

$$s = \frac{Q}{8 \pi K (b-d)} E(u, b/r, d/r, z/r) \qquad (1)$$

$$u = \frac{r^2 S/D}{4 K t} \text{ and } S/D = 4 K t u / r^2 \qquad (2)$$

The type curve correlating the E-function and 1/u for the group of wells DARA-4 and DARA-5 are shown in Figs 2 and 3. The field data curves correlating the drawdown (s) and time (t) for the pumping tests are shown in Figs 5, 6 and 7. The pumped well DARA-3 and the piezometer DARA-2 cannot be represented by this solution. The values of the matching points, coefficient of permeability and specific storage are shown in Table 2.

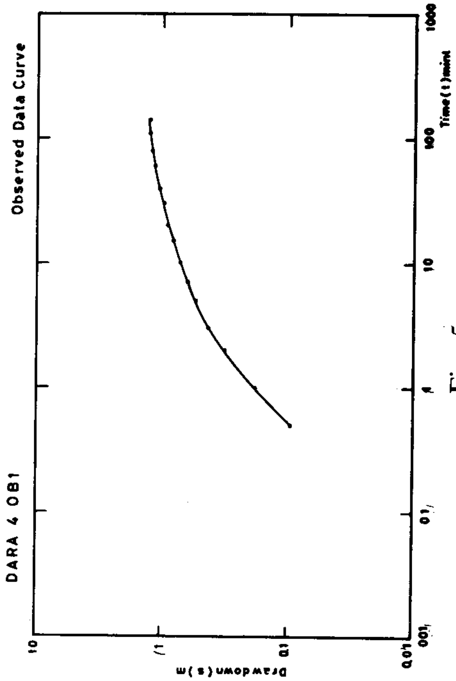



Fig. 5

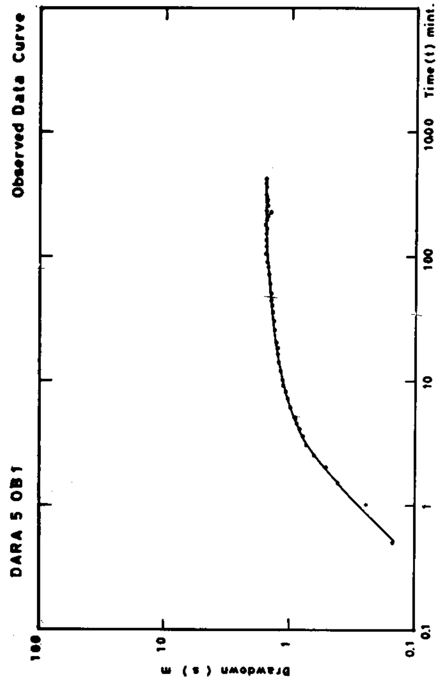



Fig. 7

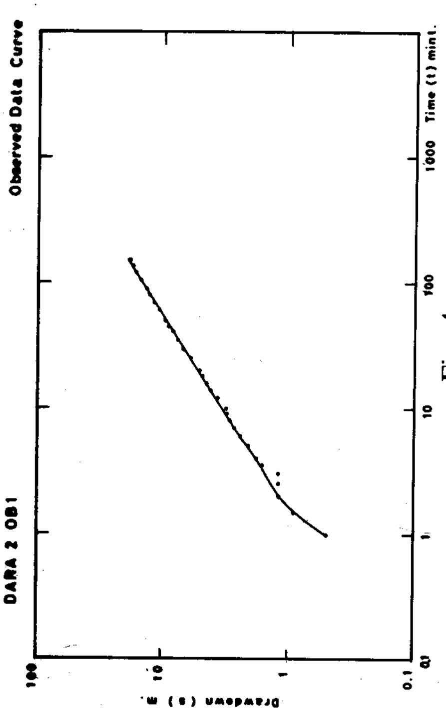



Fig. 4

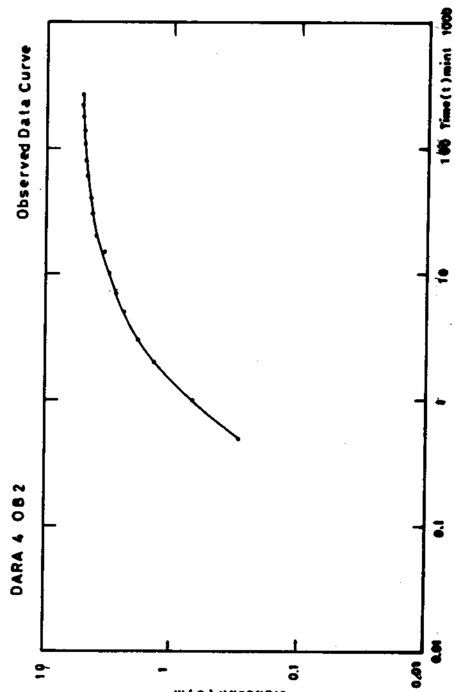



Fig. 6

**Table 2**
Analysis of pumping test by Hantush modification of Theis method

| Well No. | F(E) | l/u | s (m) | t (mint) | K (m/day) | S/D ($m^{-1}$) | D (m) |
|---|---|---|---|---|---|---|---|
| DARA4 OB1 | 1 | 100 | 0.16 | 50 | 1.162 | 0.0000133 | 280 |
| DARA4 OB2 | 1 | 100 | 0.665 | 47 | 1.1494 | 0.0000124 | 280 |
| DARA5 OB1 | 1 | 100 | 0.465 | 1.38 | 1.5707 | 0.0000017 | 142 |

(2) Hantush's Modification of the Jacob Method for Partial Penetration: For relatively long period of pumping, the drawdown (s), according to Hantush (1962), is given by

$$s = \frac{Q}{4 \pi T} \{w(u) + f_s(r/D, b/D, d/D, z/D)\} \qquad (3)$$

where:

$f_s$, is a function depending on the dimensions of the pumped well, piezometer and the aquifer.

In the same way of Jacob's method, the slope ($\triangle$s) of the straight line drawn between (s) and (t), on semilogarithmic papers, for the observed data curve is given by

$$\triangle s = \frac{2.30\, Q}{4 \pi T} \qquad (4)$$

The intercept ($t_o$) of the straight line with the absciss where s = o is given by

$$t_o = \frac{S^2 r}{2.25\, T\, e^{fs}} \qquad (5)$$

As mentioned in the first procedure, the analysis of pumping test by this method is performed for DARA4 OB1 (test No. 1), DARA4 OB2 (test No. 2) and DARA5 OB1. The graphs of the observed data curves (s Vs t) are shown in Figs 9, 10 and 11. The values of $\triangle$ s, $t_t$, $e^{fs}$, T and S are shown in Table 3.

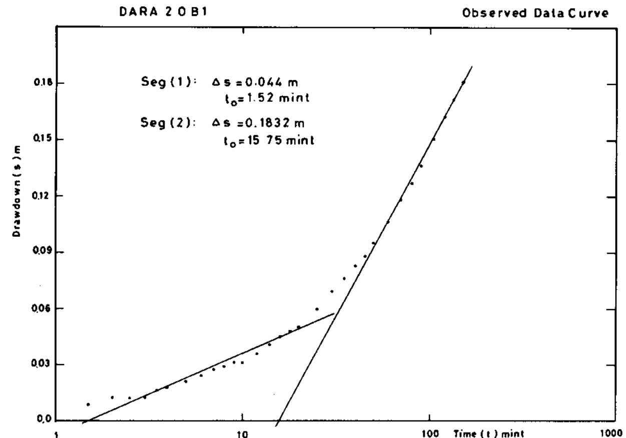



Fig. 8

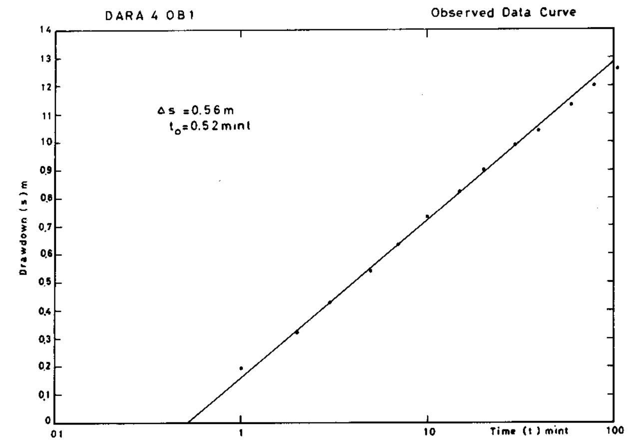
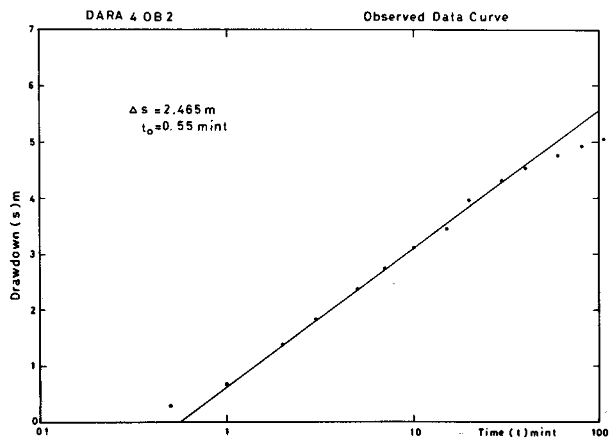



Fig. 9

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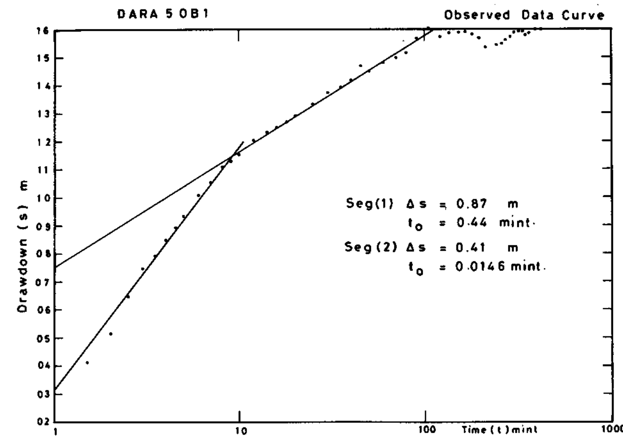


Fig. 11

**Table 3**

Analysis of pumping test by Hantush modification of Jacob's method

| Well No. | $\Delta s$ (m) | to (mint) | $e^{fs}$ | T ($m^2$/day) | S |
|---|---|---|---|---|---|
| DARA4 OB1 | 0.56 | 0.52 | 1.01033 | 152.72 | 0.001036 |
| DARA4 OB2 | 2.465 | 0.555 | 1.01033 | 142.63 | 0.001056 |
| DARA5 OB1 | 0.823 | 0.441 | 1.00974 | 302.09 | 0.005839 |
| | 0.410 | 0.015 | | 606.39 | 0.000399 |

The following correction introduced by de Glee for partial penetration would be used for Theis solution.

$$\frac{Q_P}{Q} = \frac{1n\,(r_o/r_w)}{D/b\ 1n\ (\pi b/2r_w) + 0.10 + 1n(ro/2D)} \quad \text{(6)}$$

Equation 6 would be applied to correct the discharge values of pumped partially penetrating wells in the investigated area. Table (4) shows the ratio between $Q_p/Q$ of the pumped well sin Dara Area.

**Table 4**

The correction factor due to partial penetration in Dara Area

| Well No. | DARA 3 PR | DARA 4 PR | DARA 5 PR |
|---|---|---|---|
| Correction factor | 0.8675574 | 0.6949468 | 0.8741619 |

(3) Theis Matching Method

The nonsteady-state or Theis equation may be written as

$$s = \frac{Q}{4\ \pi\ T}\ (W(u) \quad \text{(7)}$$

$$S = 4\,T\,t\,u\,/\,r^2 \quad \text{(8)}$$

Applying Theis method of analysis, a matching between Theis type curve and each of the observed data curve relating s $V_s$ t (on bilogarithmic papers) can be obtained. The data curves for the wells under test shown in Figs 4 to 7 would be used for the present analysis as well. The values of matching points, the discharge ($Q_p$), the corrected discharge due to partial penetration (Q) and the resultant hydraulic parameters T and S are tabulated in Table 5.

**Table 5**

Analysis of pumping test by Theis matching method

| Well No. | s (m) | t (mint) | l/u | W(u) | Qp ($m^3/h$) | Q ($m^3/h$) | T ($m^2/day$) | S |
|---|---|---|---|---|---|---|---|---|
| DARA 2 OB1 | 0.016 | 8.17 | 10 | 1 | 56.57 | 62.21 | 7787.8 | 0.00200 |
| DARA4 OB1 | 0.255 | 3.51 | 10 | 1 | 19.46 | 28.00 | 209.8 | 0.00169 |
| DARA4 OB2 | 1.23 | 4.60 | 10 | 1 | 80.00 | 115.1 | 178.8 | 0.00189 |
| DARA5 OB1 | 0.38 | 3.64 | 10 | 1 | 56.57 | 64.71 | 325.4 | 0.00912 |

(4) Chow's Method:

To find the values of the well function W(u) and u, Chow introduced the function:

$$F(u) = \frac{W(u)\, e^{u}}{2.3} \qquad (9)$$

The relation between F(u), W(u) and u is tabulated and nomogramed where:

$$F(u) = s/\Delta s \qquad (10)$$

The observed data curves related s vs t on semilogarithmic papers used for the analysis by this method are shown in Figs 8 to 11. The values of t, s, $\Delta$s, F(u), W(u), u and the calculated parameters T and S are tabulated in Table 6.

(5) Jacob's Method:

The equations that solve for T and S expressed by Jacob are in the form

$$T = \frac{2.30\, Q}{4\pi\ \Delta s} \qquad (11)$$

$$S = 2.25\, T\, t_0 / r^2 \qquad (12)$$

**Table 6**
Analysis of pumping test by Chow's method

| Well No. | t (mint) | s (m) | $\Delta s$ | F(u) | W(u) | u | T ($m^2$/day) | S |
|---|---|---|---|---|---|---|---|---|
| DARA2 OB1 | 3.5 | 0.0158 | 0.044 | 0.359 | 0.454 | 0.60 | 3580 | 0.00236 |
| | 120 | 0.162 | 0.183 | 0.884 | 1.846 | 0.09736 | 1420 | 0.00521 |
| DARA4 OB1 | 10 | 0.72 | 0.56 | 1.286 | 2.857 | 0.03367 | 212 | 0.00164 |
| DARA4 OB2 | 10 | 3.10 | 2.465 | 1.258 | 2.792 | 0.0360 | 198 | 0.00164 |
| DARA5 OB1 | 5 | 0.918 | 0.87 | 1.055 | 2.287 | 0.06083 | 308 | 0.00723 |
| | 50 | 1.45 | 0.41 | 3.537 | 8.134 | 0.0001725 | 694 | 0.00046 |

Jacob's method would be applied for analysing the four pumping tests carried out on the three mentioned sites. The graphs shown in Figs 8 to 11 would be used in this method as well. Table (7) shows the values of $\Delta s$, $t_o$, $Q_p$, Q and the resultant hydraulic parameters T and S.

**Table 7**
Analysis of pumping test by Jacob's method

| Well No. | $\Delta s$ (m) | to (mint) | Qp ($m^3$/h) | Q ($m^3$/h) | T ($m^2$/day) | S |
|---|---|---|---|---|---|---|
| DARA2 OB1 | 0.044 | 1.52 | | | 6513.50 | 0.001751 |
| 0.1832 | 15.75 | | | 1564.39 | 0.004356 | |
| DARA4 OB1 | 0.56 | 0.52 | 19.46 | 28.00 | 219.75 | 0.001476 |
| DARA4 OB2 | 2.465 | 0.55 | 80.00 | 115.1 | 205.25 | 0.00146 |
| DARA5 OB1 | 0.87 | 0.44 | | | 326.91 | 0.00624 |
| | 0.41 | 0.0146 | | | 693.68 | 0.000440 |

(6) Theis Recovery Method:

Analysis of data resulting during recovery test is performed using Theis recovery method. This method permits the calculation of the transmissivity only. The equation derived by Theis to solve for T is

$$T = \frac{2.30\,Q}{4\,\pi\,\Delta s'} \qquad (13)$$

The four graphs of the observed data curves for three sites drawn between s' Vs the ratio t/t' are shown in Figs 12 to 15. The values of △s', Qp, Q and the calculated transmissivity T are shown in Table 8.

**Table 8**
Analysis of recovery test by Theis recovery method

| Well No. | s (m) | Qp ($m^3/h$) | Q ($m^3/h$) | T ($m^2/day$) |
|---|---|---|---|---|
| DARA2 OB1 | 0.318 | 56.57 | 65.21 | 901.2 |
| | 0.0425 | | | 6743.3 |
| DARA4 OB1 | 0.708 | 19.46 | 28.00 | 173.8 |
| DARA4 OB2 | 2.909 | 80.00 | 115.12 | 174.5 |
| DARA5 OB1 | 0.525 | 56.57 | 64.71 | 541.7 |

## 2. ANALYSIS OF PUMPING AND RECOVERY TEST DATA USING COMPUTER PROGRAMS

Computer programs for analysing pumping and recovery tests were used for the analysis of data in Dara Area. The methods of analysis are included in two separate programs. The first program uses straight line approximation method for pumping test analysis (Jacob's method) and recovery analysis (Theis recovery method). The output data are shown through plotter and screen (printer) in the form of three cycles (segments) using least squares fitting. A second method in the same program gives type curve solution. An observed data curve relating the drawdown against time of pumping on bilogarithmic papers can be available (Theis method). Theis type curve of the same cycle scale (for matching) is also available.

The second program (Theis Fit) used to calculate of best fit, transmissivity and storage coefficient by automatically fitting experimental pumping test data to the Theis equation in a least squares sense.

According to the pumping and recovery tests carried out in the area and the facilities provided by the two mentioned programs, the following methods are applied for data analysis to solve for T and S.

— Type curve solution (Theis matching method).
— Theis Fit.
— Straight line approximation method (Jacob's method).
— Recovery test analysis (Theis recovery method).

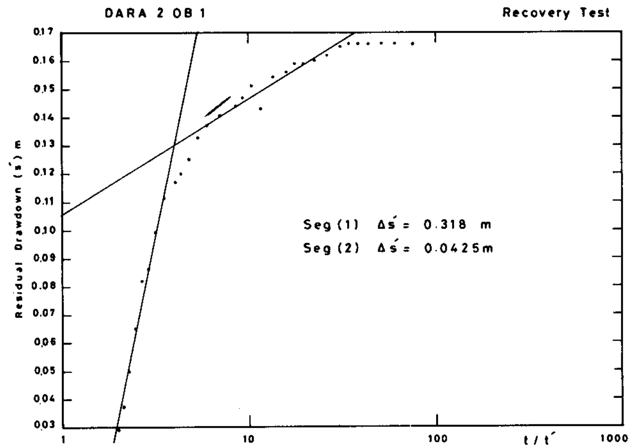


Fig. 12

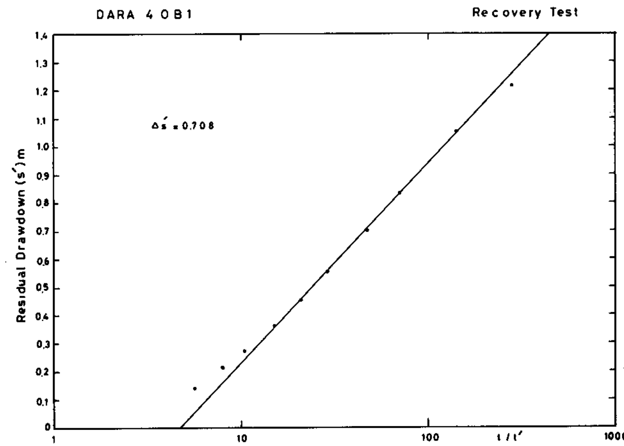


Fig. 13

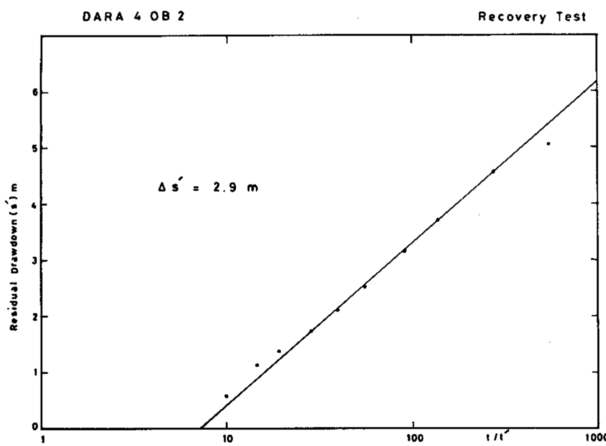


Fig. 14

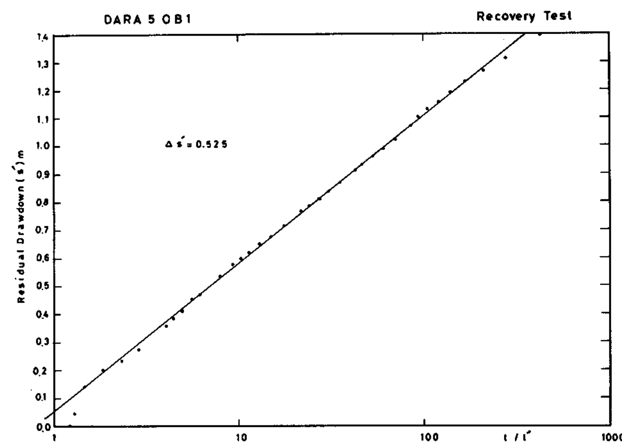


Fig. 15

**(1) Type Curve Solution (Theis Matching Method):**

By feeding the computer with the field data, a graph on bilogarithmic papers relation the drawdown (s) and the time since pumping started, (t) is obtained (Figs 16 to 19). The method is applied for the four pumping tests carried out in the three sites of the study area. The data obtained from matching each of the four curves with the type curve and the hydraulic parameters are shown in Table 9.

**Table 9**

Analysis of pumping test by Theis method (computer)

| Well No. | s (m) | t (mint) | W(u) | l/u | Qp ($m^3/h$) | Q ($m^3/h$) | T ($m^2/day$) | S |
|---|---|---|---|---|---|---|---|---|
| DARA2 OB1 | 0.0163 | 8.40 | 1 | 10 | 56.57 | 65.21 | 7644 | 0.002019 |
| DARA4 OB1 | 0.2545 | 4.00 | 1 | 10 | 19.46 | 28.00 | 210 | 0.001931 |
| DARA4 OB2 | 1.3259 | 4.30 | 1 | 10 | 80.00 | 115.12 | 166 | 0.001638 |
| DARA5 OB1 | 0.6858 | 7.25 | 1 | 10 | 56.57 | 64.71 | 180 | 0.010090 |

**(2) Theis Fit Method:**

This method is simply done by feeding the computer with field data (s and t). The program automatically match the data with the values of Theis type curve using least squares method to calculate the parameters T and S. The output parameters for the running four pumping tests are tabulated in Table 10.

**Table 10**

Analysis of pumping test by Theis Fit (computer)

| Coefficient | DARA2 OB1 | DARA4 OB1 | DARA4 OB2 | DARA5 OB1 |
|---|---|---|---|---|
| T ($m^2/day$) | 1886 | 223 | 254 | 638 |
| S | 0.004075 | 0.001580 | 0.001111 | 0.001396 |

**(3) Straight Line Approximation Method (Jacob's Method):**

The computer output in this method is in the form of straight line graph on semilogarithmic papers between s and t (Figs 20 to 23). The slope of the straight line ($\triangle$s) and the hydraulic parameters T and S are available for each test. The values of T and S would be corrected due to partial penetration as in the case of the

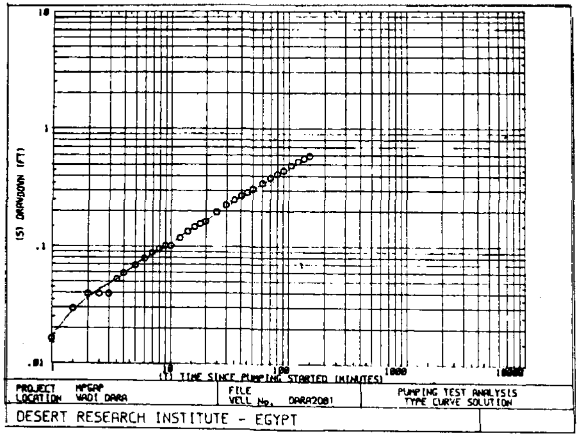


Fig. 16

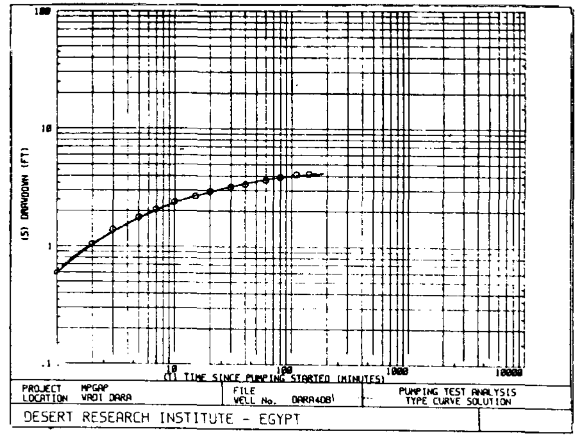


Fig. 17

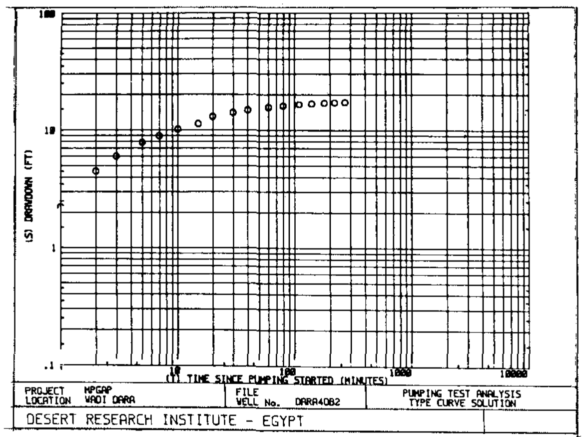


Fig. 18

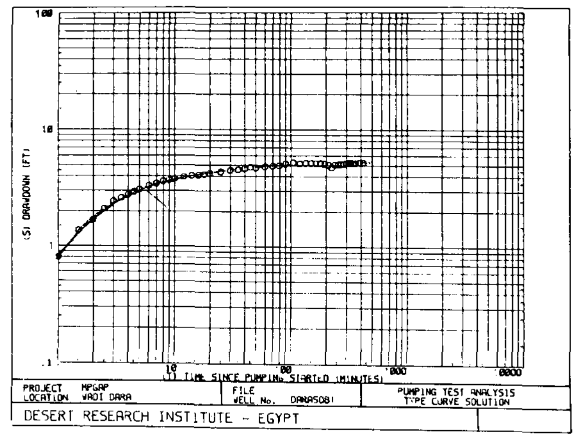


Fig. 19

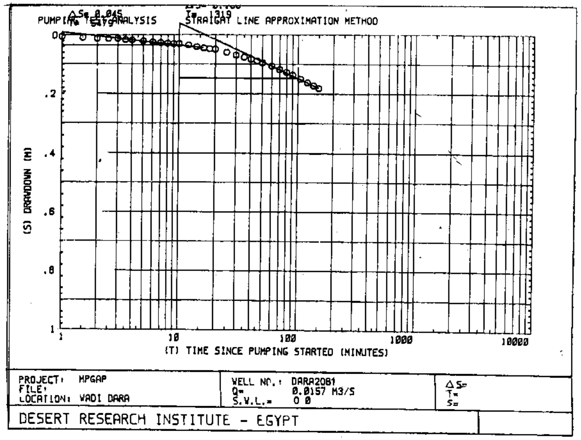


Fig. 20

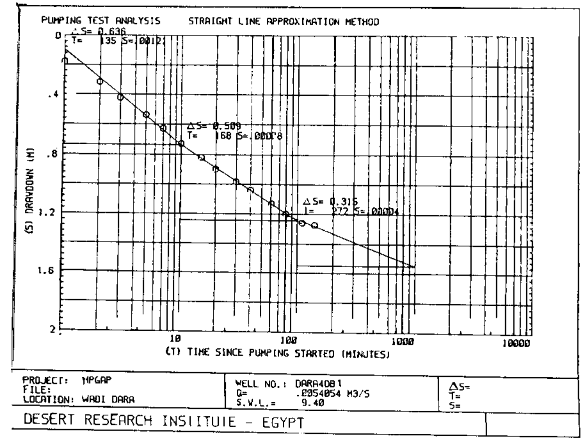


Fig. 21

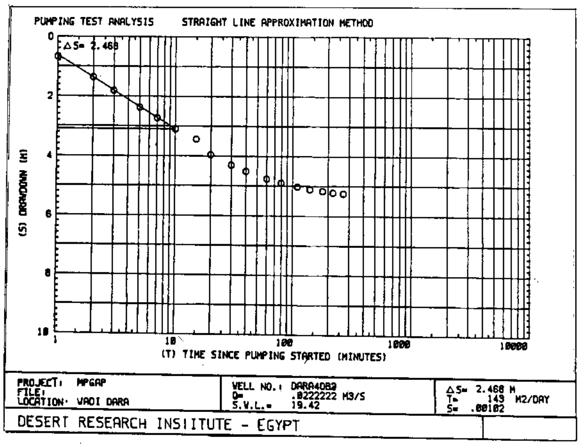


Fig. 22

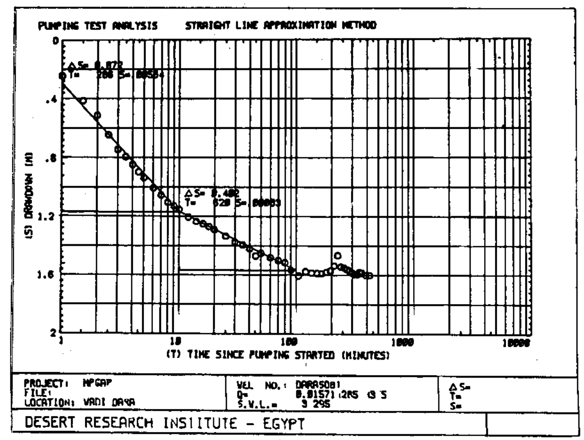


Fig. 23

previous methods. Table 11 shows the output of hydraulic parameters by the computer, the correction factors due to partial penetration (listed in Table 4) and the parameters after correction.

**Table 11**

Analysis of pumping test by straight line approximation method (computer)

| Well No. | Computer parameters | | Correction factor | Corrected parameters | |
|---|---|---|---|---|---|
| | T ($m^2$/day) | S | | T ($m^2$/day) | S |
| DARA2 OB1 | 5479 | 0.001543 | 0.8675574 | 6315 | 0.001778 |
| | 1319 | 0.00395 | | 1520 | 0.004553 |
| DARA4 OB1 | 153 | 0.00103 | 0.6949468 | 220 | 0.001482 |
| DARA4 OB2 | 143 | 0.00102 | 0.6949468 | 206 | 0.001468 |
| DARA5 OB1 | 286 | 0.00564 | 0.8741619 | 327 | 0.006452 |
| | 620 | 0.00033 | | 709 | 0.0003775 |

### (4) Recovery Test Analysis:

The method of analysing the recovery test data by the computer is the same as the procedure of analysing the straight line approximation method. Figs 24 to 27 show the correlation between the residual drawdown (s') and the ratio (t/t') on semilogarithmic papers for the four recovery tests performed in the three sites of the sudy area. Table 12 shows the transmissivity T as obtained by the computer and the corrected values of T due to partial penetration.

**Table 12**

Analysis of recovery test data by Theis recovery method (computer)

| Well No. | Computer calculated T ($m^2$/day) | Correction factor | Corrected T ($m^2$/day) |
|---|---|---|---|
| DARA2 OB1 | 782 | 0.8675574 | 901 |
| | 5849 | | 6742 |
| DARA4 OB1 | 121 | 0.6949468 | 174 |
| DARA4 OB2 | 121 | 0.6949468 | 174 |
| DARA5 OB1 | 473 | 0.8741619 | 541 |

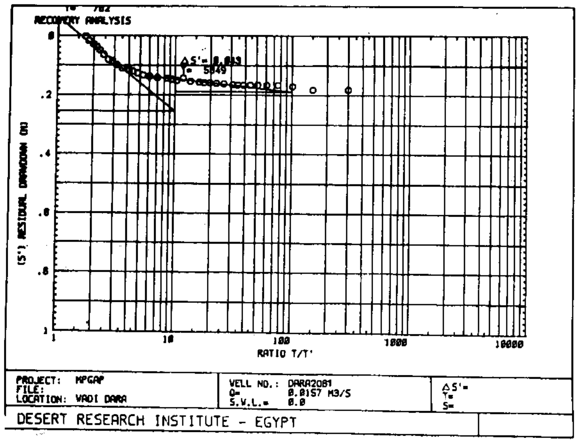


Fig. 24

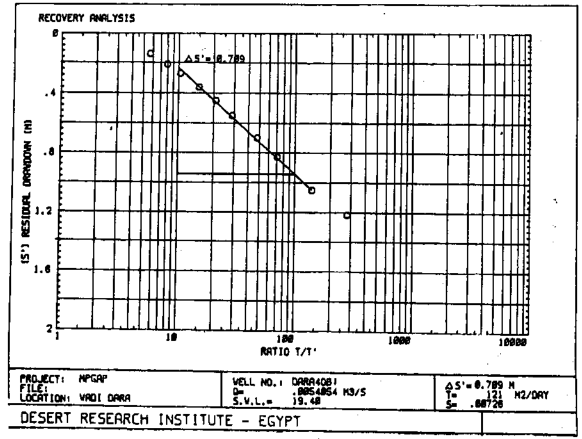


Fig. 25

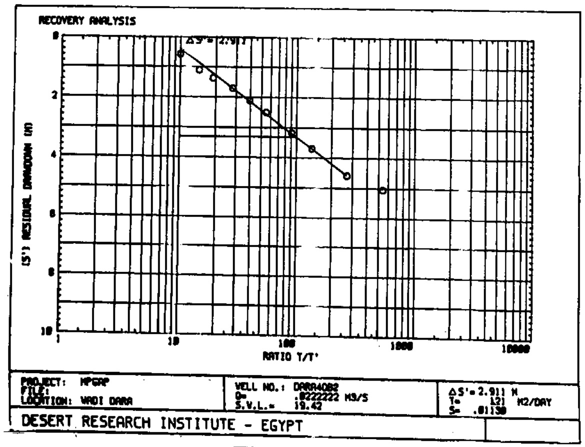


Fig. 26

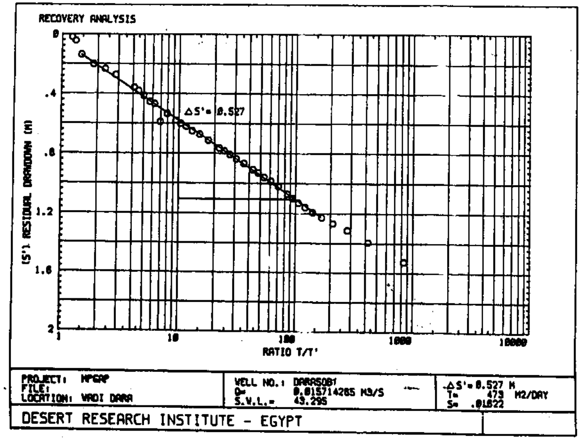


Fig. 27

Analysis of pumping and recovery tests are carried out in three sites in Dara Area. The hydraulic parameters are calculated by six methods manually (Hantush modification of Theis and Jacob methods for partial penetration, Theis matching, Chow, Jacob and Theis recovery methods), beside four methods run by computer programs (type curve solution, Theis Fit, straight line approximation and Theis recovery methods). A summary of the calculated parameters by the whole of the mentioned methods is tabulated in Table 13.

According to the values of the parameters shown in Table 13, it can be concluded that:

1. There is good similarity between the values of the parameters calculated manually and by the computer programs for the identical methods, accordingly, it is recommended to use such programs in analysis of pumping and recovery test.
2. The existence of more than one value of T and S in straight line analysis of some tests (as in Dara-2 and Dara-5) is due to more than one slope in the straight line of the field data curve. This may indicate the existence of nearby adjacent faults which recharge or deplete the aquifer (depending on the difference in the value of s).
3. The variation in the values of the hydraulic parameters for the different methods of analysis may be due to the variations in the boundary conditions and the assumptions for each method which may not be fully satisfied in the study area. There is no correction due to partial penetration applied in deriving T in Hantush modification of Jacob method beside the value of $e^{fs}$ used in deriving S is very near to unity which leads to very minor effect for partial penetration.
4. The deviation of the field data curves from straight line (semilogarithmic graphs) or from Theis matching curves (bilogarithmic graphs) is due to the complicated subsurface structures in the study area and formation of leaky aquifers. The order of magnitude of the storage coefficient value, which lies between confined and unconfined aquifers is also an evidence for semiconfined condition which was not clearly observed during subsurface studies.

According to the aforementioned reasons, it is more convenient to treat the two sites, Dara-4 and Dara-5, as semiconfined aquifers using Walton's method.

The method used for analysis is similar to Theis matching method with a family of type curves each with different value of r/L where L = TC. Performing the pumping test analysis by Walton's method using equations 7 and 8 to solve for T and S. The values of the matching points r/L, L, C and the parameters T and S for the main two sites of the study area is shown in Table 14.

## CONCLUSIONS

The aquifer in Dara Area is of semiconfined type. The average hydraulic parameters resulting from the different methods of analysis mentioned before for three sites in Dara Area are as follows:

DARA 3: (Piezometer DARA2) The values of transmissivity range between 1420 and 1886 $m^2$/day with average weighted value of 1600 $m^2$/day. The values of storativity range between 0.0015 and 0.0090 with average weighted value of 0.004.

DARA4: (Piezometer DARA4) The values of transmissivity range between 143 and 325 $m^2$/day with average weighted value of 200 $m^2$/day. The values of storativity range between 0.00104 and 0.00190 with average value 0.0016.

DARA: (Piezometer DARA5) The values of transmissivity range between 180 and 327 $m^2$/day with average weighted value of 300 $m^2$/day. The values of storativity range between 0.005 and 0.009 with average weighted value of 0.006.

N.B. The higher values for T and S in both DARA2 and DARA5 due to the existence of barriers will not be considered in evaluation of the weighted average value of T and S.

## ACKNOWLEDGEMENT

The authors are grateful to the authorities of the Desert Research Institute for providing the pumping test data and the facilities of the computer works.

**Table 13**

Summary of calculated values of hydraulic parameters in Dara Area

| Well No. | Hantush/ Theis | | Hantush/ Jacob | | Chow | | Theis matching manual | | Theis matching computer | | Theis fit computer | | Straight line appr. (Jacob) manual | | Straight line appr. (Jacob) computer | | Theis recovery manual | Theis recovery computer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | S | T | S | T | S | T | S | T | S | T | S | T | S | T | S | T | T |
| | | | | | 3580 | 0.00236 | | | | | | | 6514 | 0.00175 | 6315 | 0.00178 | 901 | 901 |
| DARA2 OB1 | | | | | | | 7788 | 0.00200 | 7644 | 0.00202 | 1886 | 0.00408 | | | | | | |
| | | | | | 1420 | 0.00521 | | | | | | | 1564 | 0.00154 | 1520 | 0.00455 | 6749 | 6742 |
| DARA4 OB1 | 325 | 0.00372 | 153 | 0.00104 | 212 | 0.00164 | 210 | 0.00169 | 210 | 0.00193 | 223 | 0.00158 | 220 | 0.00148 | 220 | 0.00148 | 174 | 174 |
| DARA4 OB2 | 322 | 0.00347 | 143 | 0.00106 | 198 | 0.00164 | 179 | 0.00189 | 166 | 0.00164 | 254 | 0.00111 | 205 | 0.00148 | 206 | 0.00147 | 175 | 174 |
| | | | 302 | 0.00584 | 308 | 0.00723 | | | | | | | 327 | 0.00624 | 327 | 0.00645 | | |
| DARA5 OB1 | 223 | 0.00024 | | | | | 325 | 0.00912 | 180 | 0.01009 | 638 | 0.00139 | | | | | 542 | 541 |
| | | | 606 | 0.00040 | 694 | 0.00046 | | | | | | | 694 | 0.00044 | 709 | 0.00038 | | |

T is in $m^2$/day

**Table 14**

Analysis of pumping test data by Walton's semiconfined method

| Well No. | s (m) | t (mint) | W(u, r/L) | l/u | r/L | L (m) | C (day) | T ($m^2$/day) | S |
|---|---|---|---|---|---|---|---|---|---|
| DARA4 OB1 | 2.438 | 3.20 | 10 | 10 | 0.07 | 157.14 | 112.500 | 219 | 0.00161 |
| DARA4 OB2 | 10.210 | 2.85 | 10 | 10 | 0.08 | 137.50 | 86.150 | 215 | 0.00141 |
| DARA5 OB1 | 5.334 | 5.05 | 10 | 10 | 0.25 | 24.00 | 2.485 | 232 | 0.00903 |

# LIST OF SYMBOLS

| | | |
|---|---|---|
| T | Transmissivity of the aquifer | ($m^2$/day) |
| S | Storage coefficient, or storativity | (dimensionless) |
| S/D | Specific Storage Coefficient | ($m^{-1}$) |
| D | Thickness of the saturated part of water-bearing layer | (m) |
| Q | Rate of discharge of fully penetrating well | ($m^3$/h) |
| $Q_p$ | Rate of discharge of partially penetrating well | ($m^3$/h) |
| $\triangle s$ | Drawdown of the groundwater head | (m) |
| $\triangle s'$ | Residual drawdown after pumping stopped | (m) |
| t | Time since pumping started | (mint) |
| t' | Time since pumping stopped | (mint) |
| $\triangle s$ | Slope of straight line relating s and t | |
| $\triangle s'$ | Slope of straight line relating s' and t/t' | |
| $t_o$ | Interception of the straight line with the absciss where s=o | (mint) |
| K | Hydraulic conductivity of water-bearing layer | (m/day) |
| L | Leakage factor of water-bearing layer | (m) |
| C | Hydraulic resistance of semi-previous layer | (day) |
| r | Distance from observation well to pumped well | (m) |
| $r_w$ | Radius of pumped well | (m) |
| $r_o$ | Radius of influence of pumped well | (m) |
| b | Total length of well penetrating the aquifer | (m) |
| b' | Total length of Piezometer Penetrating the aquifer | (m) |
| d | The screen length of well penetrating the aquifer | (m) |
| d' | The screen length of piezometer penetrating the aquifer | (m) |
| Z = | (b' + d')/2 | (m) |
| W(u) | Well function of u | |
| u = | $r^2S/4\ Tt$ dimensionless and $S = 4\ Ttu/r^2$ | |

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# تقدير المعاملات الهيدرولوكية لمنطقة وادي داره
# خليج السويس - مصر

أحمد صفوت سويدان و ابراهيم حسن حميدة

يشمل هذا البحث تقدير المعاملات الهيدروليكية ( السماحية ومعامل التخزين ) لمنطقة وادي دارة في محاولة لتقييم الخزان الجوفي بها بهدف استصلاح المنطقة للزراعة . وقد تم تحليل بيانات تخارب الضخ والتعويض التي أجريت لثلاثة مواقع بالمنطقة بست طرق تقليدية وأربع طرق باستخدام برنامج للحاسب الآلي . وقد ثبت وجود تماثل بين النتائج المستخلصة من الطرق التقليدية والناتجة بواسطة الحاسب الآلي مما يجعلنا نوصي باستخدام برنامج الحاسب الآلي هذه لتحليل تجارب الضخ والتعويض بأمان .

تبين من النتائج المستخلصة أن الخزان الجوفي بالمنطقة من النوع الشبه محصور الذي تقطعه كثير من الفوالق التي تكون نوع من العوائق .

تعتبر هذه الدراسة قاعدة أساسية لدراسات مرحلية لتحديد إمكانيات الخزان المائي بمنطقة الدراسة تمهيداً لعمل نموذج لتمثيل المنطقة بواسطة الحاسب الآلي .