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Pyramids Plateau Groundwater Lowering Activity

Contract No. EDH-I-00-08-00024-00 Order No.2

BASIS OF DESIGN REPORT

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Pyramids Plateau Groundwater Lowering Activity
USAID Contract No. EDH-I-00-08-00024-00-Order No.02

BASIS OF DESIGN REPORT

June 2010

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Table of Contents

1. Groundwater Lowering Targets…… 1

2. Groundwater Modeling …….…… 1

2.1 Base Case …… 1
2.2 Alternatives …… 2

3. Hydraulic Analysis ……... 5

3.1 Assumptions …….. 5

3.2 Results …… 6

3.3 Design …… 7

Appendices

A. Existing Pump Curves

1. Groundwater Lowering Targets

Groundwater lowering targets agreed with the Supreme Council on Antiquities are as follows:

- East of Wadi Temple, at the low portion of the existing underpass in limestone bedrock, SCA indicated that they would like to protect the lowest point in the lowest point in the area (which is the underpass) from damage from moisture. The elevation bottom elevation is 14.23 m-asl, and the capillary rise measured by AECOM in the area was 1.7 m. Therefore the groundwater lowering target should be 14.23 - 1.7 = 12.5 m-asl.

- Sphinx. The groundwater under the Sphinx would, as a result of the groundwater lowering in the Wadi Temple area be on the order of 12.5 m-asl, which should be sufficient to protect the Sphinx (approx 20 m-asl) from damage from moisture.

- Workers Area. SCA requested a target level of 13.0 m-asl in the area south of the parking lot.

2. Groundwater Modeling

The groundwater model was applied to refine the dewatering well system configuration.

2.1 Base Case

The base system that was considered included the following wells:

- Sphinx area
  - Eight existing wells (W-1 to W-8) retained
  - Seven new wells installed in limestone (A-1 to A-7)

- Workers Area
  - Wells W-1a and W-2a activated
  - Wells W-3a, W-4a and W-5a kept off
  - New well A-8 installed near fence

The new wells in limestone were assumed to have extraction flows of 50 m^3/hr, which is the approximate average of the two wells currently pumping from the limestone (90 m^3/hr at W-2 and 24 m^3/hr at W-8). The new well in the Workers Area was assumed to a flow of 75 m^3/hr.

Calculated groundwater levels after one year of operation for the base configuration are shown in Figure 2-1. These groundwater levels meet the target levels set forth above.

2.2 Alternatives

Additional model simulations were conducted with some of the wells operating in the base case turned off. Calculated groundwater levels are shown in Figures 2-2 to 2-5. Based on these results, it appears that all the wells in the Base Case are needed to meet the groundwater level targets.

Recently, SCA has undertaken to install an additional well, designated W-9, a distance of 55 m northwest of proposed well A-5. To account for this new development, Well A-5 will be removed and Well A-4 will be moved half way between A-3 and W-0

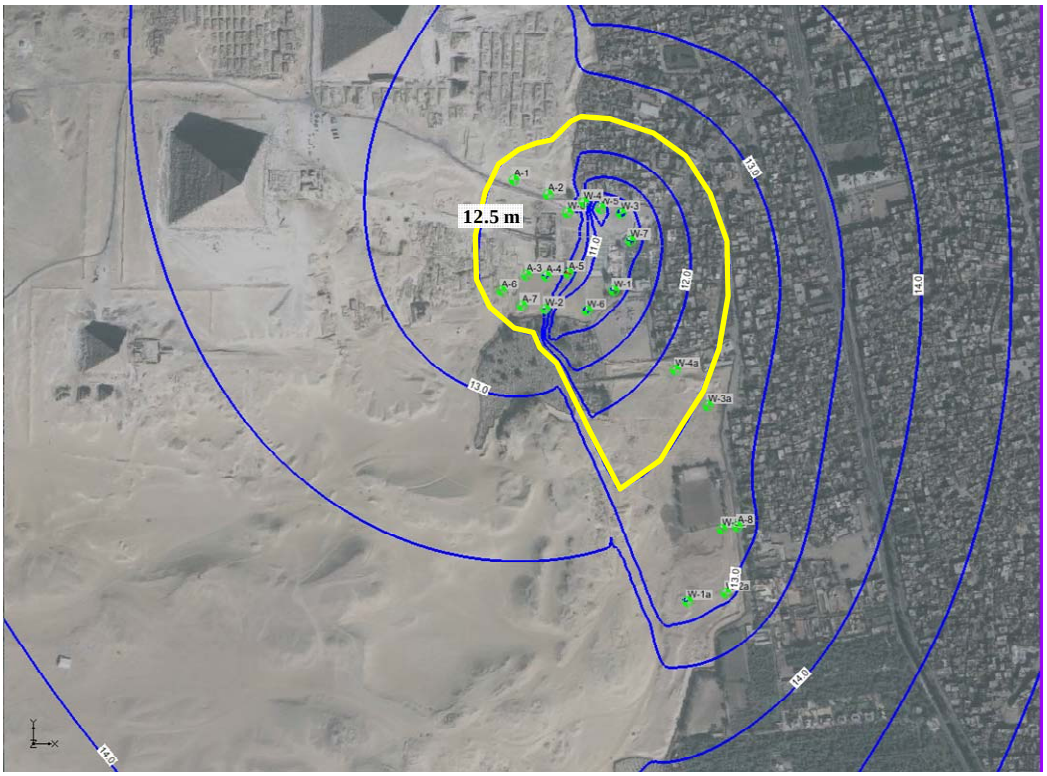


Figure 1-1. Calculated Groundwater Levels for Base Case.

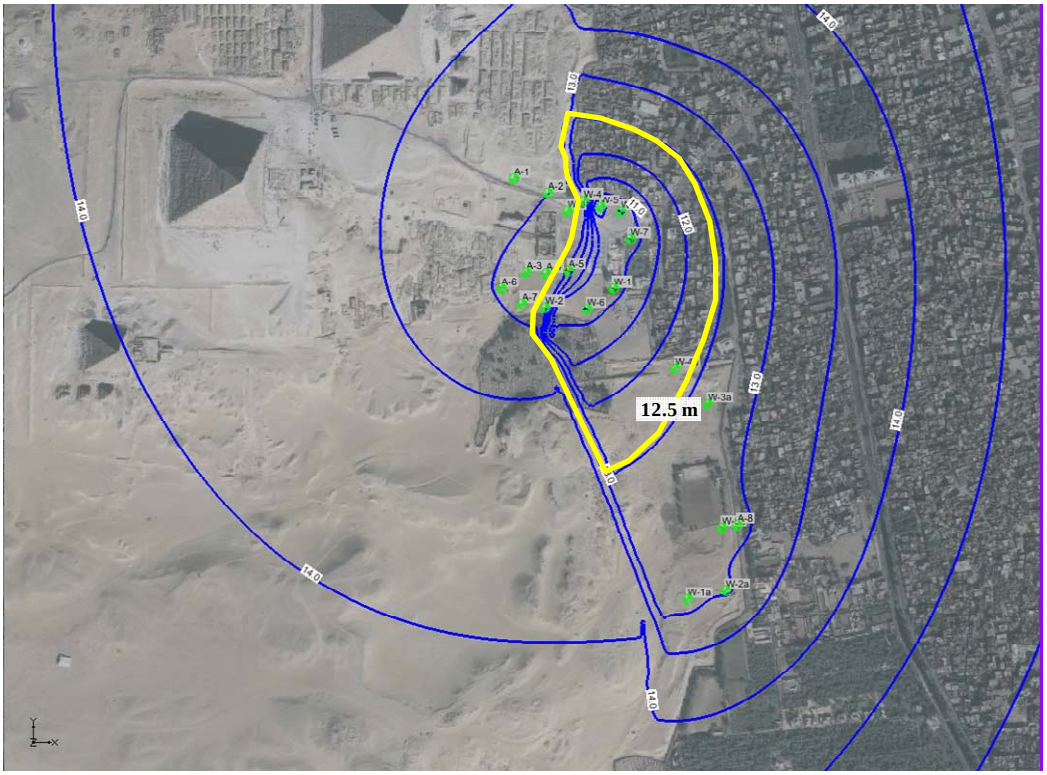


Figure 2-2. Calculated Groundwater Levels for Base Case Minus Wells A-1 and A-2

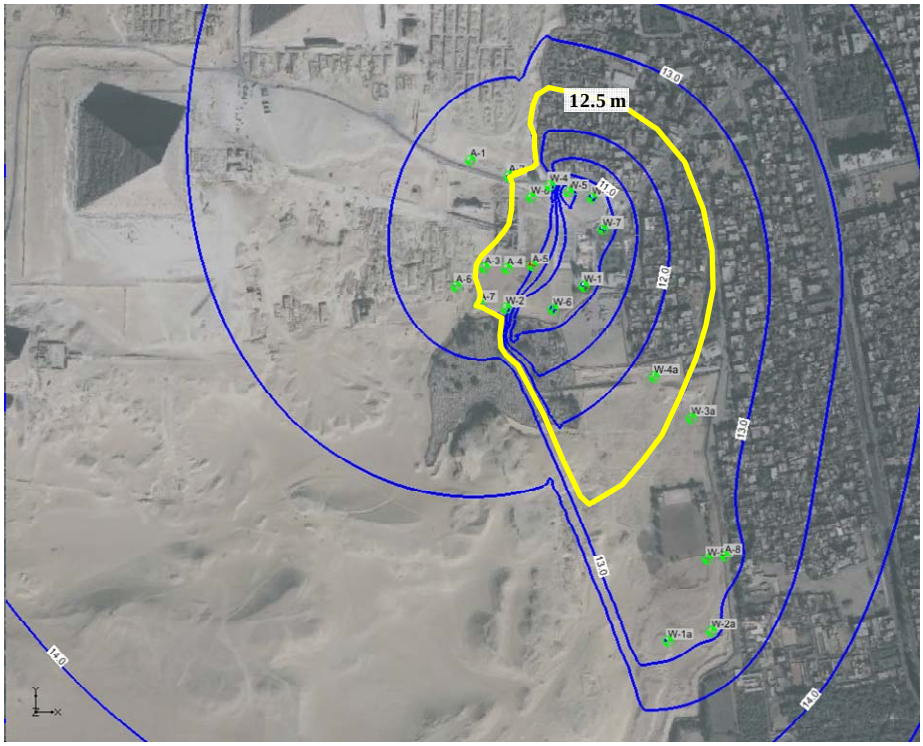


Figure 2-3. Calculated Groundwater Levels for Base Case Minus Well A-1

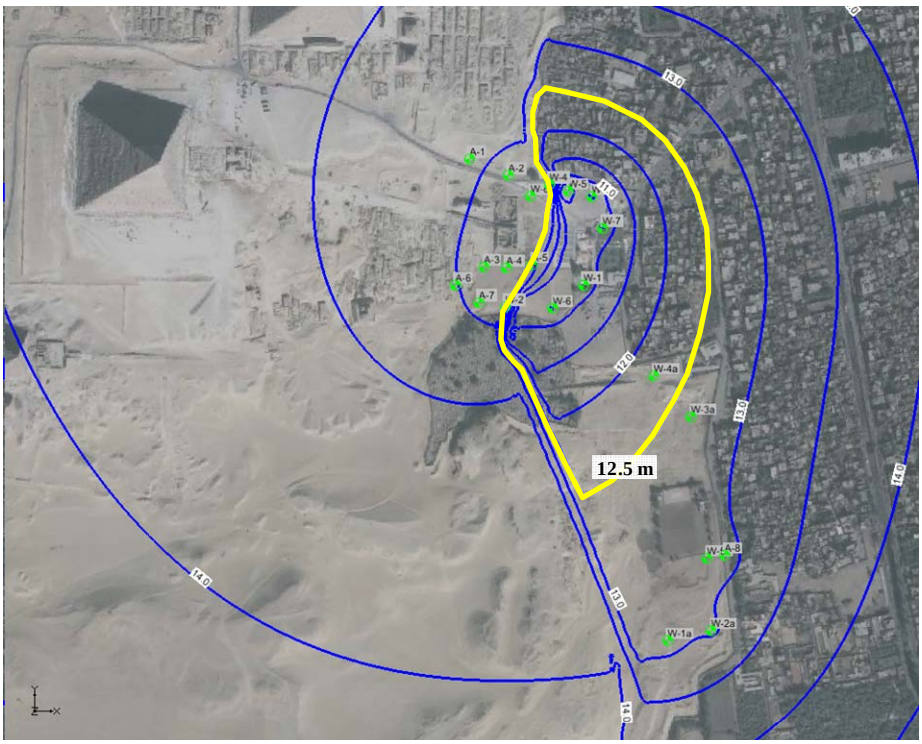


Figure 2-4. Calculated Groundwater levels for the Base Case Minus WellsA-1 and A-6

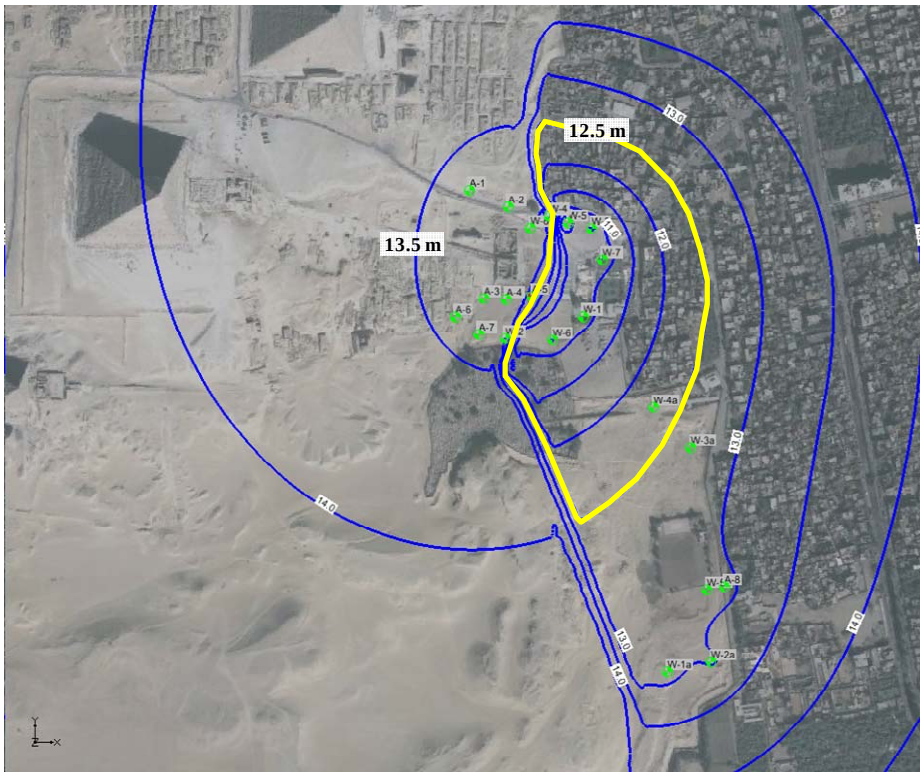


Figure 2-5. Calculated Groundwater Levels for Base Case Minus Wells A-1, A-6 and A-7

3. Hydraulic Analysis of the Pumping System

A hydraulic analysis of the existing and proposed dewatering well systems was conducted. The assumptions and results are described below.

3.1 Assumptions

- Head losses in the pipelines were calculated using the Hazen-Williams formula:

$$\Delta H = \frac{10.68\, Q^{4.87} L}{C^{1.85}\, D^{4.87}}$$

  where Q = flowrate (m^3/s) L = length (m), C = Hazen-Williams coefficient, D = diameter (m). A value of C =120 was used for the calculations to account for minor losses.

- At the discharge manhole (for existing conditions) and Mansouria Canal (for proposed conditions) a head loss equal to one velocity head was assumed.

- Drawdowns at the wells were calculated using the following expression:

$$S = S_D\ Q$$

  Where S = drawdown (m), S_D = specific drawdown ($m/m^3/hr$) and Q = flowrate (m^3/hr). The specific drawdowns were determined from the step pumping tests that were conducted at the wells, when available. The data are summarized in the Table 1.

Table 1. Well Characteristics

Well No.	Formation	Well Depth* (m)	Initial Depth to Water (m)	Saturated Depth (m)	Step test Flowrate (m^3/hr)	Drawdown (m)	Specific Drawdown ($m/m^3/hr$)	Dewatering Flowrate (m^3/hr)	Top Elevation (m)
W1	Alluvium	40	6.0	34.0	84	7.56	0.090	90	21.32
W2	Limestone	26	9.9	16.1	60	5.02	0.084	65	22.17
W3	Alluvium	40	5.6	34.4	92.5	4.87	0.053	105	20.86
W4	Alluv / Limest.	35					0.090	40	23.59
W5	Alluvium	39					0.090	105	22.04
W6	Alluvium	36					0.090	90	22.52
W7	Alluvium	35					0.090	105	20.07
W8	Limestone	40				20	0.833	24	18.88
W1-a	Alluvium	34	4.5	29.5	103	1.99	0.019		19.11
W2-a	Alluvium	34	5.8	28.2	117	10.27	0.088		19.97
W3-a	Alluvium	34	4.9	29.1	92	8.46	0.092		17.78
W4-a	Alluvium	34	7.1	26.9	100	9.76	0.098		19.45
W5-a	Alluvium	34	4.8	29.2	105	7.1	0.068		18.36

* To impervious layer

Red numbers are assumed

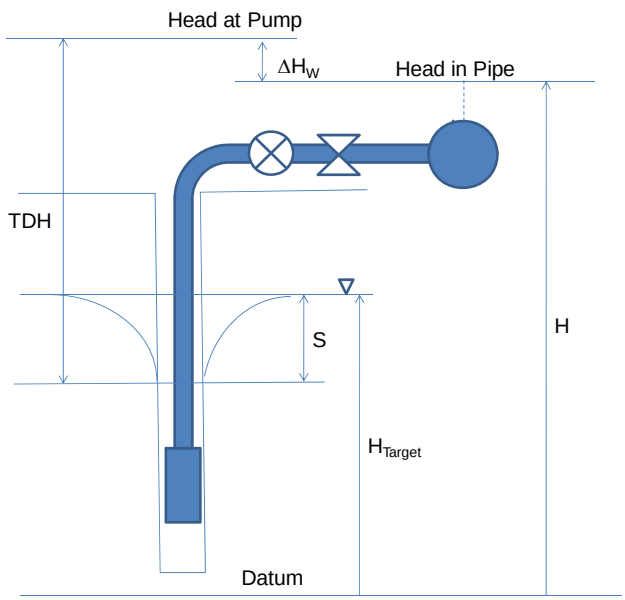
- The total dynamic head of the pumps was calculated as follows:

$$TDH = H + \Delta H_W - H_{GW}$$

where H = hydraulic head at the well head (m), ΔH_W = head loss in the pump column and fixtures (m), and H_{GW} = groundwater table elevation (m). The groundwater elevation was calculated as:

$$H_{GW} = H_{Target} - S$$

where H_{Target} = target groundwater elevation (m) and S = drawdown at the well (m).



- For new wells, the pumps were assumed to draw 50 m^3/s in the limestone and 100 m^3/s in the workers area, based on measured flows, as well as step tests (for pumps in the workers area).

3.2 Results

The hydraulic calculations were checked using measured flow and current at the different pumps. The results are summarized in the Table 2. The electrical power to the wells is dependent on assumed values of the power factor , PF, and electric motor efficiency, η_M. From this power calculation and the measured flow, the pump total dynamic head, TDH, was calculated. Also included in Table 2 are TDH values determined from the pump curves and measured flows. The latter are consistently smaller than the values obtained from the electrical measurements.

Pump TDH values from the hydraulic model are also listed in Table 2. Those are generally much lower than those obtained from the pump curves or electrical measurements. One reason is that many well head valves are throttled. For those pumps where the valves are reportedly not throttled, the THD from the hydraulic model are lower than those from the pump curve, but close to the TDH values obtained from the electrical measurements (for 2 out of 3).

These observations suggest that the pumps may be operating under their curves due to wear.

Table 2. Pump Operational Characteristics

Power Factor		PF =	0.90						
Motor efficiency		η_M =	0.88						
Pump efficiency		η_P =	0.73						
Voltage		V =	380	Volts					
Water density		ρ =	1000	kg/m^3					
Acceleration gravity		g =	9.81	ms^{-2}					
Well No	Pump Rating (HP)	Measured Flowrate (m^3/hr)	Current (Amps)	Electrical Power (kW)	Power to Pump (kW)	Power to Pump (HP)	Electrical THD (m)	Pump Curve TDH (m)	Hydraulic Model THD** (m)
1*	20	41	10	5.9	5.2	7.0	34.1	60.0	19.1
2	20	90	25	14.8	13.0	17.5	38.8	40.0	26.0
3*	20	72	15	8.9	7.8	10.5	29.1	48.0	16.8
4*	15	50	11	6.5	5.7	7.7	30.7	54.0	16.5
5*	20	56	13	7.7	6.8	9.1	32.4	55.0	17.3
6	20	60	10	5.9	5.2	7.0	23.3	54.0	22.7
7	20	80	16	9.5	8.3	11.2	27.9	45.0	22.5
8*	12	24	8	4.7	4.2	5.6	46.5	68.0	28.6
Total	473	108	64.0	56.3		Ave =	32.9	53.0	21.2
Cost per year @ $0.5/kWh				$ 24,050					
* Valve throttled									
** Hydraulic model does not account for valve throttling									
Electical Power		$P_E = 1.732\ V \times I \times PF$							
Power to pump		$P_P = P_E\ \eta_M = Q\ TDH\ \rho\ g\ /\ \eta_P$							
TDH from electrical		$TDH = P_P\ \eta_P\ /\ Q\ \rho\ g$							

3.3 Design

Results for the proposed system configuration are shown in a following figure. Pipe diameters were set to yield velocities on the order of 1 m/s to minimize friction head losses. The required pump flows and TDH are listed in Table 3. The pump heads are generally much lower than those of the existing pumps. This explains the need to throttle the well head valves to avoid drawing air.

For the design of the new system, the hydraulic model should be updated with well flows and specific drawdowns obtained from step tests at the new wells. The updated model will provide well flows and heads, and values slightly above those calculated by the model should be selected.

Table 3. Pump Characteristics

Well No.	Status	Formation	Existing Pump Flow (m^3/hr)	Existing Pump TDH (m)	Hydraulic Model Flow (m^3/hr)	Hydraulic Model TDH (m)
W-1	Existing	Alluvium	80	46	90	21
W-2	Existing	Limestone	80	46	65	17
W-3	Existing	Alluvium	80	46	105	21
W-4	Existing	Alluvium	44	63	50	16
W-5	Existing	Alluvium	80	46	105	25
W-6	Existing	Alluvium	80	46	90	22
W-7	Existing	Alluvium	80	46	105	24
W-8	Existing	Limestone	36	60	24	30
W-9	Existing	Limestone			50	16
W-1a	Existing	Alluvium			100	22
W-2a	Existing	Alluvium			100	27
A-1	New	Limestone			50	17
A-2	New	Limestone			50	16
A-3	New	Limestone			50	15
A-4	New	Limestone			50	15
A-6	New	Limestone			50	15
A-7	New	Limestone			50	15
A-8	New	Limestone			100	24

Pyramids Plateau Groundwater Lowering

HYDRAULIC PROFILE - EXISTING SYSTEM

24-Jun-10

Hazen Williams Coef C = 120

Groundwater levels

Limestone	14.5	m
Alluvium	12.0	m

Note: These calculations assume no valve throttling at the wells

Legend

Wells

W-3			
Q=	105		Flowrate (m^3/hr)
H=	21.4		Head in pipeline (m)
ΔH_w =	5.00	100	Head Loss at Well with riser Dia.
H_{GW}=	9.8	3.7	Groundwater El (m), Velocity (m/s)
TDH	16.6		Total dynamic head (m)

Pipe Segments

Q =	105		Flowrate (m^3/hr)
L =	5		Length (m)
D =	200	1.2	Diameter (mm), velocity (m/s)
ΔH =	0.03		Head loss (m)

W-8		
Q=	24	
H=	22.8	
ΔH_w =	0.31	100
H_{GW}=	-5.5	0.8
TDH	28.6	

W-4		
Q=	50	
H=	22.8	
ΔH_w =	1.24	100
H_{GW}=	7.5	1.8
TDH	16.5	

W-5		
Q=	56	
H=	22.8	
ΔH_w =	1.54	100
H_{GW}=	7.0	2.0
TDH	17.3	

W-3		
Q=	72	
H=	22.5	
ΔH_w =	2.46	100
H_{GW}=	8.2	2.5
TDH	16.8	

Q =	24		Q =	50		Q =	56		Q =	72													
L =	36		L =	10		L =	21		L =	30													
D =	150	0.4	D =	150	0.8	D =	150	0.9	D =	150	1.1												
ΔH =	0.05		ΔH =	0.06		ΔH =	0.15		ΔH =	0.34													

Q =	24		Q =	74		Q =	130		Q =	202													
L =	20		L =	43		L =	56		L =	36													
D =	150		D =	200	0.7	D =	200	1.1	D =	200	1.8												
ΔH =	0.03		ΔH =	0.13		ΔH =	0.46		ΔH =	0.67													

												Q =	271										
												L =	93										
												D =	200	2.4									
												ΔH =	2.99										

												Q =	473										
												L =	23										
												D =	200	4.2									
												ΔH =	2.97										

MH	
H =	18.5

W-7		
Q=	80	
H=	24.8	
ΔH_w =	2.46	100
H_{GW}=	4.8	
TDH	22.5	

						Q =	80																
						L =	25																
					4.7	D =	150	1.3															
						ΔH =	0.34																

W-1		
Q=	41	
H=	26.5	
ΔH_w =	0.86	100
H_{GW}=	8.31	1.5
TDH	19.1	

						Q =	41																
						L =	15																
						D =	150	0.6															
						ΔH =	0.06																

												Q =	191										
												L =	120										
												D =	200	1.7									
												ΔH =	2.02										
												Q =	150										
												L =	10										
												D =	200	1.3									
												ΔH =	0.11										

Head Loss at Well

K-Value	
0.14	Gate Valve (100mm)
0.6	Check Valve
0.3	90 short radius
0.3	Enlarger 110 to 150 mm
1.34	Total K-Value
25	Assumed Well Depth

			Q =	90								Q =	150										
			L =	92								L =	80										
			D =	150	1.4							D =	200	1.3									
			ΔH =	1.56								ΔH =	0.86										

			Q =	90					Q =	60													
			L =	12					L =	10													
			D =	150	1.4				D =	150	0.9												
			ΔH =	0.20					ΔH =	0.08													

W-2		
Q=	90	
H=	29.2	
ΔH_w =	3.74	100
H_{GW}=	6.9	3.2
TDH	26.0	

W-6		
Q=	60	
H=	27.5	
ΔH_w =	1.75	100
H_{GW}=	6.6	2.1
TDH	22.7	

Pyramids Plateau Groundwater Lowering

HYDRAULIC PROFILE - PROPOSED SYSTEM

24-Jun-10

Hazen Williams Coef	C =	120	
New limestone wells	Q_L =	50	m³/hr
New workers area wells	Q_W =	100	m³/hr
Well Connection pipe Diam	D_C =	150	mm

Groundwater levels

Limestone	12.5	m
Alluvium	12	m
Workers Area	13	m

Legend

Wells

W-3			
Q=	105		Flowrate (m³/hr)
H=	21.4		Head in pipeline (m)
ΔH_w =	5.00	100	Head Loss at Well with riser Dia.
H_{GW}=	9.8	3.7	Groundwater El (m), velocity (m/s)
TDH	16.6		Total dynamic head (m)

Pipe Segments

Q =	105		Flowrate (m³/hr)
L =	5		Length (m)
D =	200	1.1	Diameter (mm), velocity (m/s)
ΔH =	0.03		Head loss (m)

Head Loss at Well

K-Value	
0.14	Gate Valve (100mm)
0.6	Check Valve
0.3	90 short radius
0.3	Enlarger 100 to 150 mm
1.34	Total K-Value
25	Assumed Well Depth

A-1		
Q=	50	
H=	23.3	
ΔH_w =	1.24	100
H_{GW}=	8.0	1.8
TDH	16.5	

A-2		
Q=	50	
H=	22.9	
ΔH_w =	1.24	100
H_{GW}=	8.0	1.8
TDH	16.1	

W-8		
Q=	24	
H=	22.5	
ΔH_w =	0.31	100
H_{GW}=	-7.5	0.8
TDH	30.3	

W-4		
Q=	50	
H=	22.4	
ΔH_w =	1.24	100
H_{GW}=	7.5	1.8
TDH	16.1	

W-5		
Q=	105	
H=	22.7	
ΔH_w =	5.00	100
H_{GW}=	2.6	3.7
TDH	25.1	

W-3		
Q=	105	
H=	22.3	
ΔH_w =	5.00	100
H_{GW}=	6.4	3.7
TDH	20.9	

Q =	50	
L =	80	
D =	150	0.8
ΔH =	0.46	

Q =	50	
L =	8	
D =	150	0.8
ΔH =	0.05	

Q =	100	
L =	75	
D =	200	0.9
ΔH =	0.38	

Q =	24	
L =	36	
D =	150	0.4
ΔH =	0.05	

Q =	50	
L =	10	
D =	150	0.8
ΔH =	0.06	

Q =	105	
L =	21	
D =	150	1.7
ΔH =	0.48	

Q =	105	
L =	15	
D =	150	1.7
ΔH =	0.34	

Q =	124	
L =	20	
D =	200	1.1
ΔH =	0.15	

Q =	174	
L =	46	
D =	300	0.7
ΔH =	0.09	

Q =	279	
L =	48	
D =	300	1.1
ΔH =	0.23	

Q =	384	
L =	93	
D =	400	0.8
ΔH =	0.20	

A-3		
Q=	50	
H=	21.9	
ΔH_w =	1.24	100
H_{GW}=	8.0	1.8
TDH	15.1	

Q =	100	
L =	42	
D =	200	0.9
ΔH =	0.21	

Q =	50	
L =	12	
D =	150	0.8
ΔH =	0.07	

W-7		
Q=	105	
H=	22.4	6.2
ΔH_w =	4.07	100
H_{GW}=	2.6	
TDH	23.9	

Q =	105	
L =	25	
D =	150	1.7
ΔH =	0.57	

A-6		
Q=	50	
H=	21.7	
ΔH_w =	1.24	100
H_{GW}=	8.0	1.8
TDH	14.9	

Q =	150	
L =	50	
D =	400	0.3
ΔH =	0.02	

Q =	50	
L =	12	
D =	150	0.8
ΔH =	0.07	

Q =	50	
L =	84	
D =	150	0.8
ΔH =	0.48	

Q =	489	
L =	120	
D =	400	1.1
ΔH =	0.39	

Q =	90	
L =	15	
D =	150	1.4
ΔH =	0.26	

Q =	50	
L =	10	
D =	150	0.8
ΔH =	0.06	

Q =	200	
L =	80	
D =	400	0.4
ΔH =	0.05	

A-4		
Q=	50	
H=	22.1	
ΔH_w =	1.24	100
H_{GW}=	8.0	1.8
TDH	15.3	

W-9		
Q=	50	
H=	22.5	
ΔH_w =	1.24	100
H_{GW}=	8.0	1.8
TDH	15.7	

W-1		
Q=	90	
H=	21.7	
ΔH_w =	3.74	100
H_{GW}=	3.9	3.2
TDH	21.5	

Q =	579	
L =	10	
D =	400	1.3
ΔH =	0.04	

Q =	1,284	
L =	234	
D =	600	1.3
ΔH =	0.72	

Mansouria Canal

Control Room

H= 20

Q =	250	
L =	46	
D =	400	0.6
ΔH =	0.04	

Q =	315	
L =	92	
D =	400	0.7
ΔH =	0.13	

Q =	405	
L =	80	
D =	400	0.9
ΔH =	0.19	

Q =	984	
L =	385	
D =	600	1.0
ΔH =	0.64	

Q =	300	
L =	420	
D =	300	1.2
ΔH =	2.27	

Q =	50	
L =	16	
D =	150	0.8
ΔH =	0.09	

Q =	65	
L =	12	
D =	150	1.0
ΔH =	0.11	

Q =	90	
L =	10	
D =	150	1.4
ΔH =	0.17	

A-7		
Q=	50	
H=	21.8	
ΔH_w =	1.24	100
H_{GW}=	8.0	1.8
TDH	15.1	

W-2		
Q=	65	
H=	21.8	
ΔH_w =	2.03	100
H_{GW}=	7.0	2.3
TDH	16.8	

W-6		
Q=	90	
H=	21.7	
ΔH_w =	3.74	100
H_{GW}=	3.9	3.2
TDH	21.6	

A-8		
Q=	100	
H=	23.1	
ΔH_w =	4.56	100
H_{GW}=	4.0	3.5
TDH	23.6	

Q =	100	
L =	5	
D =	150	1.6
ΔH =	0.10	

W-1a		
Q=	100	
H=	28.4	
ΔH_w =	4.56	100
H_{GW}=	11.1	3.5
TDH	21.9	

W-2a		
Q=	100	
H=	26.7	
ΔH_w =	4.56	100
H_{GW}=	4.2	3.5
TDH	27.0	

Q =	200	
L =	196	
D =	200	1.8
ΔH =	3.60	

Q =	100	
L =	5	
D =	150	1.6
ΔH =	0.10	

Q =	100	
L =	90	
D =	150	1.6
ΔH =	1.86	

APPENDIX A

Existing Pump Curves

20HP Pump used for Wells 1,2,3,5,6,7

caprari
pumping power

Technical data

20 HP

COMPANY
WITH QUALITY SYSTEM
CERTIFIED BY DNV
=ISO 9001/2000=

E8S55/3A + MAC620-8V

Requested data

Flow	90 m³/h
Head	40 m
Fluid	Clean Water
Pumpe type	Single head pump
No. of pumps	1

Operating pump data

Flow	90.4 m³/h
Head	40.4 m
Shaft power	13.6 kW
Efficiency	74.8%
Head H(Q=0)	64.4 m
Head loss in check valve	0.688 m
Discharge connection	DN100

Motor data

Frequency	50 Hz
Rated voltage	400 V
Nominal speed	2860 1/min
Number of poles	2
Rated power P2	15 kW
Rated current	31.5 A
Motor type	3~
Insulation class	Y
Degree of protection	IP 68

Operating limits

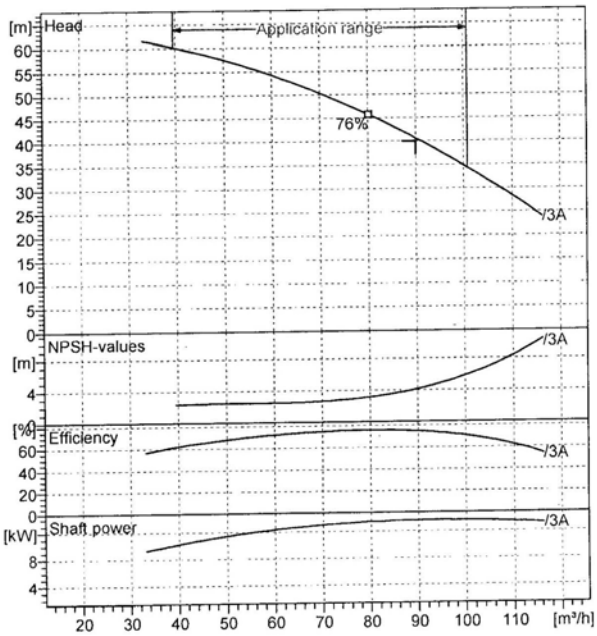
Starts per hour max.	15
Maximum temperature of pumped fluid	30 °C
Maximum content of solid	40 g/m³
Max. Density	998 kg/m³
Max. viscosity	1 mm²/s

General data

Weight	118 kg

Materials

PUMP CONSTRUCTION	.
Valve casing	Cast iron
Conical valve	Cast iron/Stainless steel
Suction casing	Cast iron
Stage casing	Cast iron
Shaft	Stainless steel
Impeller	Cast iron
Wear ring	Rubber
Strainer	Stainless steel
Cable guard	Stainless steel
Shaft coupling	Stainless steel
MOTOR CONSTRUCTION	.
Upper bracket	Cast iron
Lower bracket	Cast iron
Stator shell	Stainless steel
Shaft	Stainless steel
Seal ring	Steel/rubber
Sand guard	Rubber
Winding	Insulated copper
Thrust bearing	Michell type



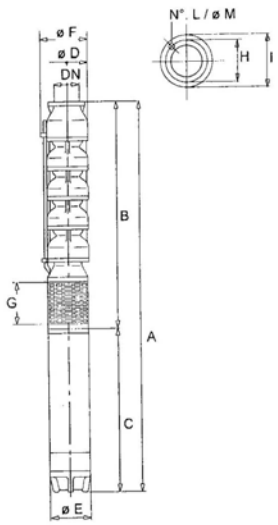
ISO 9906 GRADE 2

Operating data

Q [m³/h]	H [m]	P [kW]	Eff. [%]	NPSH [m]
70	50.3	12.8	75	2.66
80	45.8	13.1	76	3.14
95	37.8	13.3	73.2	4.86
100	34.8	13.4	70.7	5.79

Dimensions mm

A = 1607
B = 795
C = 812
D = 168
DN = 100
E = 143
F = 181
G = 160
H = 145
I = 166
L = 6
M = 11.5



Remarks:

15 HP Pump in Well W-4

caprari
pumping power

Technical data

COMPANY
WITH QUALITY SYSTEM
CERTIFIED BY DNV
=ISO 9001/2000=

E6S55/6P + MAC615-8V

Requested data

Flow	52 m³/h
Head	52 m
Fluid	Clean Water
Pumpe type	Single head pump
No. of pumps	1

Operating pump data

Flow	52.1 m³/h
Head	52 2 m
Shaft power	10.6 kW
Efficiency	69 9%
Head H(Q=0)	88 m
Head loss in check valve	0.369 m
Discharge connection	G3"

Motor data

Frequency	50 Hz
Rated voltage	400 V
Nominal speed	2870 1/min
Number of poles	2
Rated power P2	11 kW
Rated current	23 5 A
Motor type	3~
Insulation class	Y
Degree of protection	IP 68

Operating limits

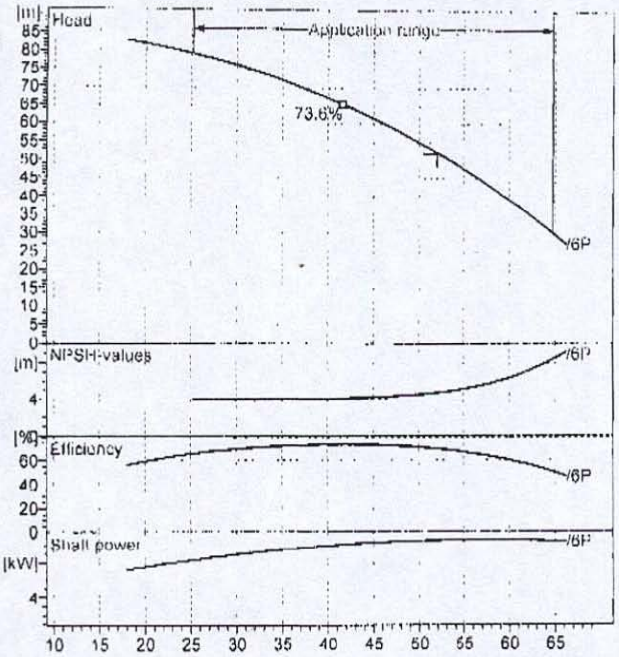
Starts per hour max.	15
Maximum temperature of pumped fluid	30 °C
Maximum content of solid	40 g/m³
Max Density	998 kg/m³
Max. viscosity	1 mm²/s

General data

Weight	110 kg

Materials

PUMP CONSTRUCTION	
Valve casing	Cast iron
Conical valve	Cast iron/Stainless steel
Suction casing	Cast iron
Stage casing	Cast iron
Shaft	Stainless steel
Impeller	Cast iron
Wear ring	Rubber
Strainer	Stainless steel
Cable guard	Stainless steel
Shaft coupling	Stainless steel
MOTOR CONSTRUCTION	
Upper bracket (4")	Brass
Upper bracket (6")	Cast iron
Lower bracket (4")	Aluminium
Lower bracket (6")	Cast iron
Stator shell	Stainless steel
Thrust bearing (4")	Steel
Thrust bearing (6")	Michell type
Sand guard	Rubber

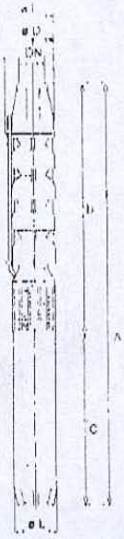


Operating data ISO 9906 GRADE 2

Q [m³/h]	H [m]	P [kW]	Eff. [%]	NPSH [m]
44	62 8	10 2	73 4	4.18
48	57 0	10.4	72.0	4.37
52	52 3	10 6	69 9	4 72
58	46 1	10 6	66 1	5 35

Dimensions mm

A 1809
B = 1072
C 737
D = 141
DN G3"
E 143
F = 150
G = 124



12 HP Pump in Well W-8

caprari
pumping power

Technical data

COMPANY
WITH QUALITY SYS
CERTIFIED BY DN
=ISO 9001/20(

E6S55/5K + MAC612-8V

Requested data

Flow	36 m³/h
Head	60 m
Fluid	Clean Water
Pumpe type	Single head pump
No. of pumps	1

Operating pump data

Flow	36.1 m³/h
Head	60.4 m
Shaft power	8.1 kW
Efficiency	73.5%
Head H(Q=0)	73.4 m
Head loss in check valve	0.178 m
Discharge connection	G3"

Motor data

Frequency	50 Hz
Rated voltage	400 V
Nominal speed	2860 1/min
Number of poles	2
Rated power P2	9.2 kW
Rated current	20.5 A
Motor type	3~
Insulation class	Y
Degree of protection	IP 68

Operating limits

Starts per hour max.	15
Maximum temperature of pumped fluid	30 °C
Maximum content of solid	40 g/m³
Max. Density	998 kg/m³
Max. viscosity	1 mm²/s

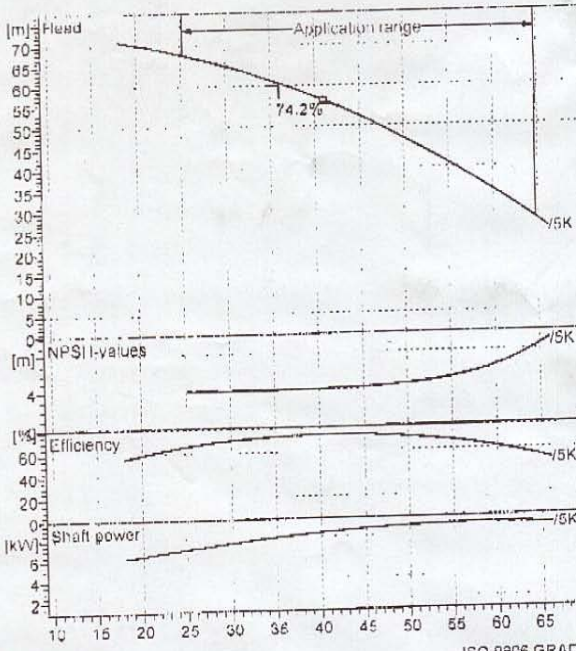
General data

Weight	101 kg

Materiale

PUMP CONSTRUCTION	
Valve casing	Cast iron
Conical valve	Cast iron/Stainless steel
Suction casing	Cast iron
Stage casing	Cast iron
Shaft	Stainless steel
Impeller	Cast iron
Wear ring	Rubber
Strainer	Stainless steel
Cable guard	Stainless steel
Shaft coupling	Stainless steel
MOTOR CONSTRUCTION	
Upper bracket (4")	Brass
Upper bracket (6")	Cast iron
Lower bracket (4")	Aluminium
Lower bracket (6")	Cast iron
Stator shell	Stainless steel
Thrust bearing (4")	Steel
Thrust bearing (6")	Michell type
Sand guard	Rubber

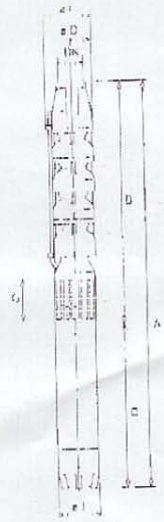
Remarks:



ISO 9906 GRAD

Operating data

Q [m³/h]	H [m]	P [kW]	Eff. [%]	NPSH [m]
36	60.0	8.07	73.4	4.01

Dimensions mm

A = 1679
B = 957
C = 722
D = 141
DN = G3"
E = 143
F = 150
G = 124