DESERT PLANNING IN THE NEW VALLEY OF NILE RIVER IN EGYPT

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INTRODUCTION

A new planning project is presented for the development the west desert in Egypt. The study will add a new area of 700,000 ha to be utilized for agricultural, and industrial establishments, as well as creating a new society in the desert. The plan involves pumping water from Naser Lake upstream Aswan High Dam into a new channel passing through the desert with total length of 350 km . The channel will start with 5 km closed conduit, then goes in open channel with several branches. Water management assessment for flow in the channel network is presented. An optimization study for the cost of the project components is also carried out.

GENERAL LAYOUT

The proposed layout of the new channel and its intake were selected from 5 alternatives; four of them were downstream Aswan High Dam, and one was in the upstream. A topographical, geological, hydrological as well as economical qualitative and quantitative assessment narrowed the list of the 5 routes to one alternative, which lays in the west desert of Egypt. Its intake started from Naser Lake, upstream Aswan High Dam, as shown in Fig. 1. The lake water level is annually changing from 147.5 to 178.5 meter above sea level. The lake bank level near intake is 200 m. A huge pump station is suggested to lift water with capacity of about 600 m^3/sec., and static head of 57.5 m. The channel will start with 5 km of pipeline, then 50 km of main concrete lining open channel followed by another 300 km of natural channel. The expected agricultural area served by this channel is 700,000 ha, divided into 9 zones, each is served by a tree-type open channel networks.

Fig. 1 Map of the Nile River and the new channel.

OPTIMAL DESIGN OF PUMP STATION AND PIPE LINES

The selected position for pump station is E:703072.56 and N:994467.87. The station takes its water through 3 concrete circular tunnels with diameter of 10.0 m and flow velocity < 2.0 m/sec. Screens are provided to prevent weeds and debris. Also, isolated gates are used for periodical maintenance of pumps. The design discharge is estimated according to the water demand which is decided as 70 m^3/ha/day in winter and 140 m^3/ha/day in summer. Pump station is divided into 4 separate unit structures, each has 12 centrifugal pump and one additional for emergency. The design discharge for each pump is 13.88 m^3/sec., and the static head is 57.5 m measured from the L.W.L as worst case. The diameter of pipe lines are decide according to the hydraulic and economical assessment through optimal design procedures. For economical study, three items should be considered; pipe line cost, pump station cost, and energy cost. General equations for such integrated study are

$$ACPL = CRF \times W \times UCPL \quad (1)$$

$$ACPS = P \times UCPS \quad (2)$$

$$ACE = P \times T \times UCE \quad (3)$$

where ACPL is the annual cost of one pipe line in US Dollar, CRF is the capital recovery factor, W is the weight of steel pipeline, UCPL is the price of installing unit length of pipeline, ACPS is the annual cost of pump station, P is the power consumption in kW, UCPS is the price for pump station per kW, ACE is the annual cost of energy, T is the time in hours, UCE is the energy price per kW, and TAC is the total annual cost. As a result, the economical diameter of pipeline is 3.5 m.

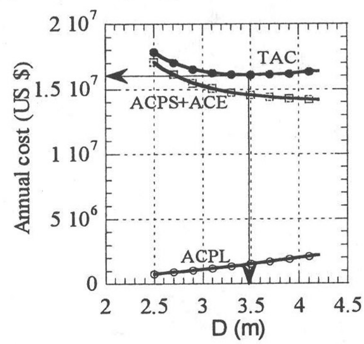

Fig. 2 Relation between cost and pipe diameter.

DESIGN OF CONCRETE LINED MAIN CHANNEL

The group of pipelines are discharging water into a vast concrete basin which passes the water to the main canal. Due to the nature of land in this area which may be considered a loose sand, the main canal is lined with a layer of concrete with thickness 20 cm laying over another layer of polyethylene for protection. The dimensions of that channel are selected with respect to hydraulic and economical considerations. Several cross sections are tested with different side slopes, Z, by using Manning equation $V = 1/n\ (A/P)^{2/3}\ (I)^{1/2}$ and the ratio B/Y, where V is the mean velocity, n is the Manning coefficient, A is the area cross section, P is the wetted parameter, I is the longitudinal slope, B is the bottom width, and Y is the water depth. The velocity is selected to be < 2.0 m/sec. Figure 3 shows an example of such study. As a result, the selected width is 40 m, water depth is 6.5 m, and side slope is 1.5 : 1, as shown in Fig. 4.

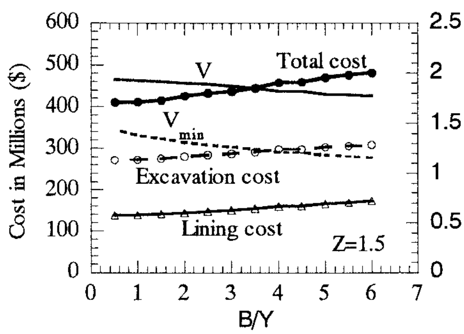

Fig. 3 Relation between channel dimensions and cost.

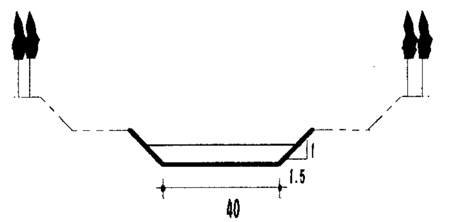

Fig. 4 Typical cross section of the lining main channel.

CHANNEL NETWORKS SYSTEM

Nine branch channels are developed from the main canal. Each channel feeds a group of small branches designed in a tree-type, as shown in Fig. 5. For the management and optimization of the discharges passing into such branches, and to calculate the gradually varied flow depths at any point in the network, a general numerical solution (FDM) is presented using computer modeling. The general equations used in the algorithm are the continuity and momentum equations for steady non-uniform flow,

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = 0 \tag{4}$$

$$\frac{\partial Q}{\partial t} + \frac{\partial (QV)}{\partial x} + gA\frac{\partial h}{\partial x} + J(Q,h) = 0 \tag{5}$$

where Q is the discharge, V is the velocity, A is the flow cross-section, J is the slope due to friction. The representation of the network in zones 1 and 2 is shown in the following example, see Fig. 6, where the underline numbers represent obtained discharges.

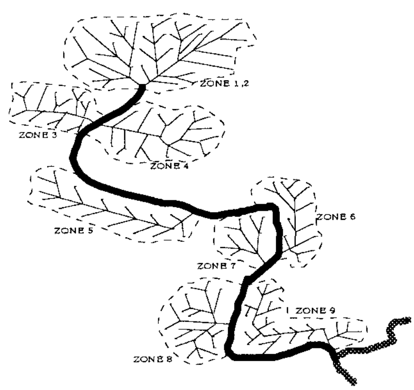

Fig. 5 General layout plan of the network.

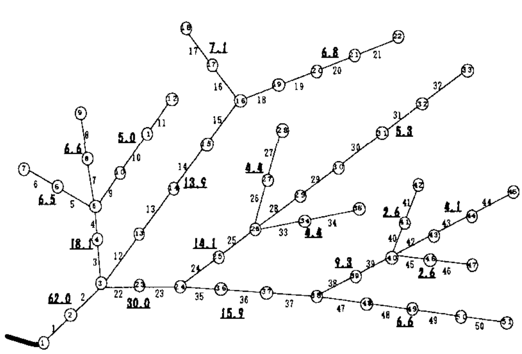

Fig. 6 Definition sketch of the channel network at zones 1&2.

In Table 6, The discharge, Q, the bed slope, I, the bottom width, B, the branch length, L, and water depths, DEP1 and DEP2 are presented for every node and branch in zone 1&2. The other zones branches are similarly presented.

Table 1 The obtained results from the numerical model.

BRANCH	NODE	I	B	L	DEP1	DEP2	Q1	Q2
1	1-2	0.00009	12.4	5000	5.08	4.66	62.0	62.0
2	2-3	0.00009	12.4	5000	4.66	3.75	62.0	62.0
3	3-4	0.00009	6.7	4000	3.75	3.35	18.1	18.1
4	4-5	0.00009	6.7	4000	3.35	2.55	18.1	18.1
5	5-6	0.00012	4.2	5000	2.55	2.61	6.5	6.5
6	6-7	0.00012	4.2	5000	2.61	2.10	6.5	6.5
7	5-8	0.00012	4.2	5000	2.55	2.62	6.6	6.6
8	8-9	0.00012	4.2	5000	2.62	2.10	6.6	6.6
9	5-10	0.00010	4.3	6000	2.55	2.49	5.0	5.0
10	10-11	0.00010	4.3	5000	2.49	2.39	5.0	5.0
11	11-12	0.00010	4.3	5000	2.39	2.17	5.0	5.0
12	3-13	0.00012	5.9	6000	3.75	3.68	13.9	13.9
13	13-14	0.00012	5.9	6000	3.68	3.57	13.9	13.9
14	14-15	0.00012	5.9	6000	3.57	3.35	13.9	13.9
15	15-16	0.00012	5.9	6000	3.35	2.82	13.9	13.9
16	16-17	0.00012	4.6	6000	2.82	2.66	7.1	7.1
17	17-18	0.00012	4.6	5500	2.66	2.28	7.1	7.1
18	16-19	0.00012	4.6	5000	2.82	2.79	6.8	6.8
19	19-20	0.00012	4.6	5000	2.79	2.73	6.8	6.8
20	20-21	0.00012	4.6	5000	2.73	2.59	6.8	6.8
21	21-22	0.00012	4.6	5000	2.59	2.28	6.8	6.8
22	3-23	0.00011	10.1	5000	3.75	3.53	30.0	30.0
23	23-24	0.00011	10.1	5000	3.53	3.01	30.0	30.0
24	24-25	0.00012	7.1	5000	3.01	2.80	14.1	14.1
25	25-26	0.00012	7.1	5000	2.80	2.25	14.1	14.1
26	26-27	0.00009	4.8	5000	2.25	2.31	4.4	4.4
27	27-28	0.00009	4.8	6000	2.31	2.41	4.4	4.4
28	26-29	0.00012	4.9	5000	2.25	2.26	5.3	5.3
29	29-30	0.00012	4.9	5000	2.26	2.28	5.3	5.3
30	30-31	0.00012	4.9	5000	2.28	2.30	5.3	5.3
31	31-32	0.00012	4.9	5000	2.30	2.35	5.3	5.3
32	32-33	0.00012	4.9	5000	2.35	2.45	5.3	5.3
33	26-34	0.00009	4.8	5000	2.25	2.31	4.4	4.4
34	34-35	0.00009	4.8	6000	2.31	2.41	4.4	4.4
35	24-36	0.00010	8.5	5000	3.01	2.93	15.9	15.9
36	36-37	0.00010	8.5	5000	2.93	2.77	15.9	15.9
37	37-38	0.00010	8.5	5000	2.77	2.35	15.9	15.9
38	38-39	0.00009	7.5	5000	2.35	2.24	9.3	9.3
39	39-40	0.00009	7.5	5000	2.24	1.92	9.3	9.3
40	40-41	0.00009	4.8	5000	1.92	2.17	2.6	2.6
41	41-42	0.00009	4.8	4000	2.17	2.41	2.6	2.6
42	40-43	0.00012	4.9	5000	1.92	2.01	4.1	4.1
43	43-44	0.00012	4.9	5000	2.01	2.18	4.1	4.1
44	44-45	0.00012	4.9	5000	2.18	2.45	4.1	4.1
45	40-46	0.00009	4.8	5000	1.92	2.16	2.6	2.6
46	46-47	0.00009	4.8	4000	2.16	2.41	2.6	2.6
47	38-48	0.00012	5.5	6000	2.35	2.38	6.6	6.6
48	48-49	0.00012	5.5	6000	2.38	2.44	6.6	6.6
49	49-50	0.00012	5.5	5000	2.44	2.54	6.6	6.6
50	50-51	0.00012	5.5	5500	2.54	2.73	6.6	6.6