JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NORTH SINAI DEVELOPMENT ORGANIZATION
MINISTRY OF WATER RESOURCES AND IRRIGATION
THE ARAB REPUBLIC OF EGYPT

THE NORTH SINAI INTEGRATED RURAL DEVELOPMENT PROJECT
(PHASE Ⅲ)

(DETAILED DESIGN STUDY)

VOLUME VII : OPERATION AND MAINTENANCE REPORT

OCTOBER, 2000

SANYU CONSULTANTS INC.
PACIFIC CONSULTANTS INTERNATIONAL

CONTENTS OF OPERATION AND MAINTENANCE PLANS

List of Table

List of Figure

CHAPTER 1 PROJECT ENVIRONMENTAL CONDITIONS

CHAPTER 1 PROJECT ENVIRONMENTAL CONDITIONS

1.1 Overall Water Conveyance System

The water conveyance systems of overall beneficial areas which extended over 620,000 feddans both western (220,000 feddans) and eastern (400,000 feddans) sides of the Suez Canal, consist of 220 km long water conveyance canal with 7 lifting pumping station to supply irrigation and industrial water.

Western side of the conveyance canal, so called El Salaam Canal, and three main lifting pumping stations have been constructed and are partially being operated water supply to the reclaimed farm land based on the progress of settlement and infrastructures development of the beneficial areas.

On the other hand, Eastern side of the conveyance systems including the Suez Canal Syphon, so called Shikh Gaber El Sabah Canal, and three main lifting pumping stations have been constructed and or under construction.

Summarized major facilities along the conveyance system are tabulated in the Table 1.1-1.

1.2 Scope of the Study

Main discussion of operation and maintenance scheme in this report is Shikh Gaber El Sabah Conveyance Canal section including El Salaam No.7 Pumping Station between KM86.5 and KM 132.5 for Stage I development scheme

.

As discussed in the Basic Design Report, the development plan of the El Sir and El Kawareer project was decided to divide into two stages, such as Stage I area of 85,000 feddans beneficial area of below 90m elevation AMSL, and the Stage II beneficial area of 50,000 feddans between 90m and 110m AMSL.

Table 1.1-1 Major Facility of Conveyance Canal

Conveyance canal	Facilities	Station	Specification
El Salaam	Damietta intake	KM0.0	Max. intake discharge Q=112 m^3/s
	Conveyance canal (1)	KM 0.0-KM18.0	Length 18.0km, Qmax=112 m^3/s
	Serw drain mixing	KM18.0	Max. intake discharge Q=23 m^3/s
	Conveyance canal (1)	KM18.0-KM22.0	Length 18.0km, Qmax=134 m^3/s
	No.1 pumping station	KM22.0	Qmax=128 m^3/s
	Conveyance canal (2)	KM22.0-KM52.8	Length 30.8km, Qmax=128 m^3/s
	No.2 pumping station	KM52.8	Qmax=128 m3/s
	Main drain mixing	KM52.8	Max. intake discharge Q=86.0 m^3/s
	Conveyance canal (3)	KM52.8-KM87.0	Length 34.2km, Qmax=214.0 m^3/s
	Suez Canal Syphon	KM87.0-KM87.8	Qmax=160.0 m3/s, dia.6m x 4rows
Shikh G.S.C	Conveyance canal (3)	KM0.0-KM3.0	Length 3.0km, Qmax=120.2 m^3/s
	No.4 pumping station	KM3.0	Qmax=111.4 m3/s
	Conveyance canal (4)	KM3.0-KM14.7	Length 11.7km, Qmax=111.4 m^3/s
	Cross regulator(1)	KM14.7	Qmax=111.4 m3/s
	Conveyance canal (5)	KM14.7-KM24.8	Length 10.1km, Qmax=111.4 m^3/s
	No.5 pumping station	KM24.8	Qmax=88.1 m3/s
	Conveyance canal (6)	KM24.8-KM34.5	Length 9.7km, Qmax=88.1 m^3/s
	Cross regulator(2)	KM34.5	Qmax=88.1 m3/s
	Conveyance canal (7)	KM34.5-KM46.5	Length 12.0km, Qmax=88.1 m^3/s
	No.6 pumping station	KM46.5	Qmax=70.4 m3/s
	Conveyance canal (8)	KM46.5-KM59.2	Length 12.7km, Qmax=70.4 m^3/s
	Cross regulator(3)	KM59.2	Qmax=59.3 m3/s
	Conveyance canal (9)	KM59.2-KM75.6	Length 16.4km, Qmax=59.3 m^3/s
	Cross regulator(4)	KM75.6	Qmax=59.3 m3/s
	Conveyance canal (10)	KM75.6-KM86.5	Length 10.9km, Qmax=59.3 m^3/s
	Cross regulator(5)	KM86.5	Qmax=52.7 m^3/s
	Conveyance canal (11)	KM86.5-KM106.2	Length 19.7km, Qmax=52.7 m^3/s
	Spillway	KM106.2	Qmax=52.7 m^3/s
	Conveyance canal (12)	KM106.2-KM108.5	Length 2.3km, Qmax=52.7 m^3/s
	Sand settling basin	KM108.5-KM108.9	Qmax=52.7 m^3/s
	No.7 pumping station	KM108.9-KM109.0	Stage I : Qmax=32.5 m^3/s Stage II : Qmax=20.2 m^3/s
	Conveyance canal (13)(Pipeline)	KM109.0-KM118.4	Stage I : Length 9.4km x3rows, Qmax=32.5 m^3/s
	Discharge tank	KM118.4-KM118.6	Stage I : Qmax=32.5 m^3/s Stage II : Qmax=20.2 m^3/s
	Conveyance canal (14)	KM118.6-KM132.5	Length 13.9km, Qmax=52.7 m^3/s
	TOTAL	220.3 km	

1.3 Water Demands Fluctuation and Character of the Water Conveyance System

Average monthly water demands of irrigation and industry for both Western Area and Eastern Area is summarized in the Table 1.3-1.

Table 1.3-1 Water Demands and Beneficial Area

Month	Western Area (Discharge and Percent)	Eastern Area (Discharge and Percent)	Overall Area (Discharge and Percent)	El Kawareer (Discharge and Percent)	Stage I of El Kawareer (Disc.and %)
January	0(00)	47.37(39)	47.37(21)	22.84(43)	13.70(42)
February	41.53(40)	60.65(50)	102.18(46)	25.93(49)	15.65(48)
March	38.19(37)	77.00(64)	115.19(52)	28.65(54)	17.36(53)
April	39.99(38)	64.50(54)	104.49(47)	25.50(48)	15.38(47)
May	37.50(36)	74.10(62)	111.60(51)	24.76(47)	14.91(46)
June	103.96(100)	104.75(87)	208.71(95)	37.54(71)	22.96(71)
July	100.53(97)	120.21(100)	220.74(100)	52.66(100)	32.48(100)
August	95.63(92)	102.49(85)	198.12(90)	44.90(85)	27.59(85)
September	55.38(53)	63.76(53)	119.14(54)	25.50(48)	15.38(47)
October	17.99(17)	35.15(29)	53.14(24)	14.69(28)	8.57(26)
November	43.89(42)	37.02(31)	80.91(37)	13.93(26)	8.09(25)
December	49.45(48)	36.62(30)	86.07(39)	19.74(37)	11.75(36)

Note : Western Area consists of 6 zones with 220,000 feddans gross irrigation area, and 5 zones with 400,000 feddans for Eastern Area. Data sources of the above are Mansura Regional Irrigation Office, NSDO Kantara Office and FS report 1997, JICA.

As tabulated in the Table 1.1-1, the water conveyance systems are so large scale and specifications and function of respective facilities are not same concept for the entire systems, especially main lifting pump and water distribution system from the conveyance canal.

Monthly water requirement based on each zone base cropping pattern is much difference by sub-projects and or zones as indicated in the Table 1.3-1 and 1.3-2.

Operation and maintenance activities of the conveyance canal system both "western area" and "eastern area" will be executed by the different organization, such as joint operation of Mansula regional irrigation office and MED office for western area and NSDO for eastern area.

The Master Plan Study covering engineering, agronomy, institutional and financial aspects shall be carried out immediately and practical operation and maintenance activities shall be commenced based on the action plans.

Table 1.3-2 Water Requirement of Each Sub-Project (Zone)

(Unit : m^3/s)

Sub Project (Zone)	Area (Feddan)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	13,000	-	2.54	2.32	2.41	2.29	6.35	6.15	5.85	3.39	1.08	2.70	3.02
2	30,000	-	5.64	5.15	5.44	5.10	14.13	13.68	12.99	7.52	2.41	5.96	6.72
3	64,000	-	12.04	10.99	11.60	10.87	30.11	29.15	27.72	16.05	5.41	12.72	14.33
4	47,000	-	8.48	7.75	8.18	7.66	21.25	20.52	19.53	11.31	3.62	8.96	10.10
5	45,000	-	9.03	8.24	8.70	8.15	22.61	21.84	20.79	12.04	3.85	9.54	10.75
6	21,000	-	3.80	3.74	3.66	3.43	9.51	9.19	8.75	5.07	1.62	4.01	4.53
Sub-total	**220,000**	-	**41.53**	**38.19**	**39.99**	**37.5**	**103.96**	**100.53**	**95.63**	**55.38**	**17.99**	**43.89**	**49.45**
7	42,600	4.55	5.94	8.74	6.56	7.46	11.10	11.31	9.57	5.20	1.46	3.47	3.55
8	18,000	1.92	2.51	3.69	2.77	3.15	4.69	4.78	4.04	2.20	0.62	1.47	1.50
	64,400	5.72	7.61	10.32	9.13	11.63	15.94	16.00	13.30	9.22	5.78	5.95	4.19
9	70,000	6.17	9.33	12.80	10.27	13.55	17.74	17.73	15.34	10.82	6.30	6.10	3.82
10	70,000	6.17	9.33	12.80	10.27	13.55	17.74	17.73	15.34	10.82	6.30	6.10	3.82
11	135,000	22.84	25.93	28.65	25.50	24.76	37.54	52.66	44.90	25.50	14.69	13.93	19.74
Sub-total	**400,000**	**47.37**	**60.65**	**77.00**	**64.50**	**74.10**	**104.75**	**120.21**	**102.49**	**63.76**	**35.15**	**37.02**	**36.62**
Total	**620,000**	**47.37**	**102.18**	**115.19**	**104.49**	**111.60**	**208.71**	**220.74**	**198.12**	**119.14**	**53.14**	**80.91**	**86.07**

CHAPTER 2 OPERATION AND MAINTENANCE PLAN

CHAPTER 2 OPERATION AND MAINTENANCE PLAN

2.1 Major Function and Issues of the Conveyance Canal

Key objectives of the selection of suitable conveyance method must satisfy the water requirement of the beneficiary area, ensure the saving water and the effective use of limited water resources, and saving the cost of operation and maintenance.

Supply oriented system and demand oriented system are generally considered as water conveyance systems. In supply oriented system, water is managed by the supply side according to the requirement of beneficiaries and the system is suitable for well planned use of limited water resources. On the other hand, in demand oriented system, the water can be used by the demand of beneficiaries by their own control to some extent. In due consideration of the scale of canal and the nature of pumping facilities, the most suitable system shall be selected.

(1) Control of Water Requirement

The control of seasonal and daily amount of intake water from the Nile River is rather difficult and it is also difficult to manage water of main canal in coincide with hourly fluctuation of the water demand of the beneficiaries. For the purpose to decrease the amount of wastewater and to avoid the excess operation of pumping facilities, following factors, such as "time lag" and "regulating function of conveyance canal" shall be considered.

(2) Time-lag

The length of conveyance canal is 220 km and the water is conveyed by the seven pumping stations connecting the above conveyance canal. The amount of water demand in the beneficiary area is decided on monthly basis based on the proposed cropping pattern because of no effective rainfall in practice.

Night storage facilities with capacity of 8 hours water requirement are provided at on-farm level and the discrepancy of supply and demand is adjusted by the night storage. It takes 4 days to convey water from the Damietta Intake to El Sir & El Kawareer beneficial area, and also it takes 1 or 2 days to reach water from the main canal to on-farm level. That means control of water amount is necessary at 5 or 6 days beforehand to adjust the water demand at on-farm.

(3) Regulating Function of Conveyance Canal

The main conveyance canal of 220km long can be assumed as a large water source and water management can be made by the severe control of discharge from the conveyance

canal as reservoir to branch canal. The gross storage capacity of the conveyance canal is 30 MCM and the effective storage capacity (storage between full water level at the respective periods and 1m below full water level) is approx. 8.6 MCM and this amount is coincide to the amount of the flow for 0.6～2.0 days as shown in the Table 2.1-1.
Although it may not be sufficient regulating capacity for peak discharge in July, it will be rather effective for the discharge in other month.

Table 2.1-1 Storage Capacity of the Conveyance Canal

Section	Total storage capacity / (Effective Storage Capacity) (1,000m³)	Diversion Discharge Q (m³/s)	Regulating Duration (Total / Effective) (day)
Damietta～No.1PS	3,000 / (900)	1.0	38.2 / 10.4
No.1PS～No.2PS	6,000 / (1,600)	3.7	18.8 / 5.0
No.2PS～No.4PS	8,900 / (2,500)	69.0	1.5 / 0.4
Sub-total	18,200 / (5,000)	73.7	2.8 / 0.8
No.4PS～No.5PS	4,500 / (1,500)	43.4	1.2 / 0.4
No.5PS～No.6PS	2,300 / (700)	9.8	2.7 / 0.8
No.6PS～No.7PS	4,500 / (1,400)	38.8	1.3 / 0.4
Sub-total	11,300 / (3,600)	92.0	1.4 / 0.5
(No.7PS～No.8PS)	2,600 / (1,000)	(52.7)	(0.6 / 0.2)
Total	29,500 / (8,600)	165.7	2.1 / 0.6

(4) Supply Oriented System

No.7 Pumping Station is planned at the place of the final approach to El Sir & El Kawareen area and the discrepancy of the supply and demand will concentrate to this point. This means that El Sir & El Kawareer beneficiary area of 135,000 feddans is apt being affected by the deficiency of water. It is very common that upstream beneficiary is tending to diversion priority and downstream beneficiary is suffered from water lacking.

Judging from the above discussion, the supply oriented system and upstream water level control system shall be adopted together with the severe control of diversion water to the branch canal for saving water and the pump operation system is based on the water level of the upstream in principle.

2.2 Countermeasures and Provision of Special Facilities

(1) Emergency Care for El Salaam No.7 Pump Units Stoppage

Two types of countermeasure are considered on the sudden stop due to power failure of No.7 P.S. One is excess water in the upstream open canal even in case other upstream pumping stations stop quickly the operation. The water impounded in the canal will flow down to the lowest portion of the suction sump of the No.7 P.S, and rise the water level and overflow on the top of canal embankment. Emergency spillway is required between No.6 and No.7 P.S. to avoid canal destruction. The other is water hammer phenomena which will be occurred when the power supply sudden stop.

(a) Spillway

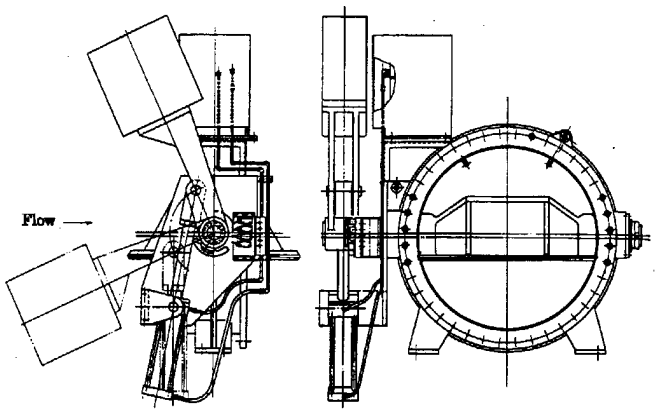
In order to prevent overflowing water on the top of the canal embankment, the spillway with outlet canal was provided to release water about 55 m^3/sec as emergency case at about 2.7 km upstream of the No.7 PS. The proposed spillway has two types water release system, one is overflow type spillway (7.50 m width with 4 spans) to discharge water automatically above normal water level on the conveyance canal, the other is radial gate type spillway (4.00 m width with 2 gates) to drain the water below normal water level on the canal during maintenance period whenever impound water below the normal water level shall be drained out.

(b) Provision of Bi-plane Valve

In order to protect pump facilities and delivery pipelines from the up-surging pressure of water hammer, Bi-Plane type butterfly valve is selected for the purpose stopping reverse flow prevention and mitigation of water hammer pressures. This valves, however, does not intend to control flow rate because No.7 pump units are operating by combining unit number and hourly control methods.

The valve is normally open by hydraulic cylinder and closed by counter weight in time within approx. 120 second (2minites). When the pump is accidentally stopped such as power failure and reverse flow starts, the valve is first closed to prevent most water from backward then slowly closed by the hydraulic cylinder acting as dash pot, while releasing some of the water. The closing time of the valve is controlled by the hydraulic cylinder after the optimum time has been determined by analyzing the transient of the water hammer (approx. 10 second for 90 % closing and 30 second for 10 % closing) for according to the delivery pressured pipeline installation.

Figure 2.2-1 shows the structures of the Bi-Plane Valve.



Figer2.2-1 Bi-plane Valve cylinder/counter weight operating type

(c) Provision of Surge Tank

One way type water surge tanks were provided to mitigate the down surging phenomenon on the respective steel pipelines of 9.40 km long with 2,400 mm diameter and 22 mm pipe thickness, although the careful selection of delivery pressured pipeline alignment was made at office level and site topographic survey.

Two units of surge tank with appropriate capacity of tank on respective pipeline were provided to prevent steel pipe buckling by negative pressures during water hammer phenomenon. The location and capacity of the tanks with appurtenant devices can be summarized as following table.

Table 2.2-1 Dimensions of Surge Tank

Facility	Location	Capacity of Tank and Shape	Diameter of Outlet Pipes	Valves and Devices
No.1 Surge Tank	KM110.300	300 m^3 (5.0m x 15.0m x 4.0m)	1,500 mm with manhole	-1,500mm check valve and butterfly valve -200mm supply pipes, stop valves, strainer and float valves
No.2 Surge Tank	KM114.700	22.4 m^3 (2.8m x 4.0m x 2.0m)	700 mm with manhole	-700mm check valve and butterfly valve -100mm supply pipes, stop valves, strainer and float valves

(2) Mitigation of Sand Intrusion into the Conveyance Canal

In order to mitigate and or prevent sand intrusion into the canal, conveyance canal was designed open canal section and box culvert section including provision of sand settling basin and opening of box culvert section.

(a) Provision of Sand Settling Basin (1)

Two kinds of sand settling basins are provided to the proposed conveyance canal for both open canal and box culvert sections. The location and capacity of respective facilities can be tabulated as following Table.

Table 2.2-2 Sand Settling Basin (1)

Station Number	Type of Facilities	Location	Size and Shape
No.1 Open Canal KM86.50-KM94.30	Type – 1	From KM 87.00 to each one kilo-meter interval	-20m x 8m x 1m = 160 m^3
Box Culvert KM94.30-KM101.80	Type – 2	KM94.30	-14m x 3.7m x 1m x 4 = 210 m^3
	Type – 3	KM 94.90, KM 95.58, KM 96.75, KM 97.65, KM 98.99, KM 99.69, KM 100.23, KM 100.83,	-2.4m x 3.7m x 0.5m x 4 = 18 m^3
No.2 Open Canal KM101.80-KM108.47	Type – 1	From KM 102.00 to each one kilo-meter interval	-20m x 8m x 1m = 160 m^3
No.3 Open Canal KM118.56-KM132.50	Type – 1	From KM119.00 to each one kilo-meter interval	-20m x 8m x 1m = 160 m^3

(b) Provision of Sand Settling Basin (2)

Sand settling basin with 2,700 m^3 capacity for Stage I development (for Stage II required capacity of 1,700 m^3) is provided immediate upstream of No.7 pumping station to mitigate sand mixed flow into the impeller of the main pump.

Method of extrusion of deposited sand in the sand settling basin is recommended by artificial flashing instead of natural flashing from the view points of topographic and hydraulic conditions. So, annual maintenance work for such extrusion of deposited sand is one of the very important activity of the project operation and maintenance work.

2.3 Pump Operation Plan

(1) Water Requirement and Water Distribution Plan

Water users of the project are agriculture (irrigation) and industrial sector. NSDO determined that irrigation water projection shall be followed the proposed land use plan for respective development stages but industrial water is divided into around 50% for each stages. Monthly base water demand projection, therefore, can be tabulated in the Table 2.3-1.

Table 2.3-1 Water Demand Projection

Month	Stage I Irrigation	Stage I Industry	Stage I Total	Stage II Irrigation	Stage II Industry	Stage II Total	Grand Total
Jan.	10.74	2.96	13.70	6.32	2.82	9.14	22.84
Feb.	12.69	2.96	15.65	7.46	2.82	10.28	25.93
Mar.	14.40	2.96	17.36	8.47	2.82	11.29	28.65
Apr.	12.42	2.96	15.38	7.30	2.82	10.12	25.50
May	11.95	2.96	14.91	7.03	2.82	9.85	24.76
Jun.	20.00	2.96	22.96	11.76	2.82	14.58	37.54
Jul.	**29.52**	**2.96**	**32.48**	**17.36**	**2.82**	**20.18**	**52.66**
Aug.	24.63	2.96	27.59	14.49	2.82	17.31	44.90
Sep.	12.42	2.96	15.38	7.30	2.82	10.12	25.50
Oct.	5.61	2.96	8.57	3.30	2.82	6.12	14.69
Nov.	5.13	2.96	8.09	3.02	2.82	5.84	13.93
Dec.	8.79	2.96	11.75	5.17	2.82	7.99	19.74
Average	**14.02**	**2.96**	**16.98**	**8.25**	**2.82**	**11.07**	**28.05**

Source: JICA F/S report 1997.

(2) Simulated Discharge of the Proposed Main Pump

Construction of the No.7 Pumping Station (PS) will be carried out dividing into two stages, for 4 units of Stage I and 3 units of Stage II development including each one unit of standby for respective stage.

Actual operation of No.7 PS in Stage I is proposed simplifying method such as numbers of pump unit and hourly control within the month to meet fluctuated water demand of beneficiaries. As tabulated in the Table 2.3-1, monthly base water demand will fluctuate from 100 % in July to 25 % in November for Stage I and from 100% in July to 26% in November after completion of Stage II development. Due to the high lifting pump with long distance delivery pressured pipelines, discharge capacity of the pumps based on numbers of pump operation buries (increase) about 20 % of the full operation of three units in Stage I for example. This range shall be decided within allowable limit of pump efficiencies. Prospected discharge for each pumps can be tabulated in the Table 2.3-2.

Table 2.3-2 Simulated Discharge of Pump

Description	Unit	Stage I			Stage II	
		1 Pump	2 Pump	3 Pump	1 Pump	2 Pump
1. Total discharge	m^3/s	**12.900**	**23.930**	**32.481**	**12.570**	**21.654**
2. Head losses of Pumping Station						
Screen	m	0.20	0.20	0.20	0.20	0.20
Suction pipe	m	0.31	0.27	0.22	0.30	0.22
Delivery pipe	m	0.88	0.76	0.62	0.88	0.62
Header pipe	m	0.37	0.35	0.34	0.37	0.34
Pipeline (H.P. ~ KM 108.985)	m	0.04	0.12	0.22	0.06	0.22
① **Sub total**	**m**	**1.80**	**1.70**	**1.60**	**1.76**	**1.60**

Description	Unit	Stage I			Stage II	
		1 Pump	2 Pump	3 Pump	1 Pump	2 Pump
3. Head losses of Pipeline (KM 108.985 ~ KM 118.360)						
Diameter x row		ϕ2,400mm x 3 row			ϕ2,400mmx2row	
Discharge of 1 row	m^3/s	4.300	7.977	10.827	6.285	10.827
② **Head losses of Pipeline**	**m**	**2.65**	**8.36**	**14.74**	**5.40**	**14.78**
4. Total head losses (① + ②)		4.45	10.06	16.34	7.169	16.38
③ **(Round up)**	m	**4.50**	**10.10**	**16.40**	**7.20**	**16.40**
5. Static head						
Discharge water level	m	92.50	92.80	92.90	92.70	92.90
Suction water level	m	8.90	9.50	9.90	9.90	9.90
④ **Static head**	m	**83.60**	**83.30**	**83.00**	**82.80**	**83.00**
6. Total head (③ + ④)						
⑤ **Total head**	m	**88.10**	**93.40**	**99.40**	**90.00**	**99.40**

(3) Pump Operation Manners for the Monthly Water Demand

The required monthly pump operation hours based on the simulated discharge of the main pumps can be tabulated in the Table 2.3-4. Discharge volume of each pump unit are estimated from the Figure 2.3-1.

Table 2.3-4 Monthly Pump Operating Hours

Month	Water Requirement ($1000m^3$)	No.1 Pump		No.2 Pump		No.3 Pump		Total Operating Hours (hr/day)
		Hours (hr/d.)	Discharge Volume ($1000m^3$)	Hours (hr/d.)	Discharge Volume ($1000m^3$)	Hours (hr/d.)	Discharge Volume ($1000m^3$)	
Jan.	1,183.68	24.00	1,108.72	1.74	74.96	0	0.00	25.74
Feb.	1,352.16	24.00	1,094.55	5.98	257.61	0	0.00	29.98
Mar.	1,499.90	24.00	1,082.04	9.70	417.86	0	0.00	33.70
Apr.	1,328.83	24.00	1,096.28	5.40	232.55	0	0.00	29.40
May	1,288.22	24.00	1,099.95	4.37	188.27	0	0.00	28.37
Jun.	1,983.74	24.00	1,040.86	21.89	942.88	0	0.00	45.89
Jul.	2,806.29	24.00	935.43	24.00	935.43	24.00	935.43	72.00
Aug.	2,383.78	24.00	991.73	24.00	991.73	10.27	400.32	58.27
Sep.	1,328.83	24.00	1,096.28	5.40	232.55	0	0.00	29.40
Oct.	740.45	15.94	740.45	0	0.00	0	0.00	15.94
Nov.	698.98	15.05	698.98	0	0.00	0	0.00	15.05
Dec.	1,015.20	21.86	1,015.20	0	0.00	0	0.00	21.86

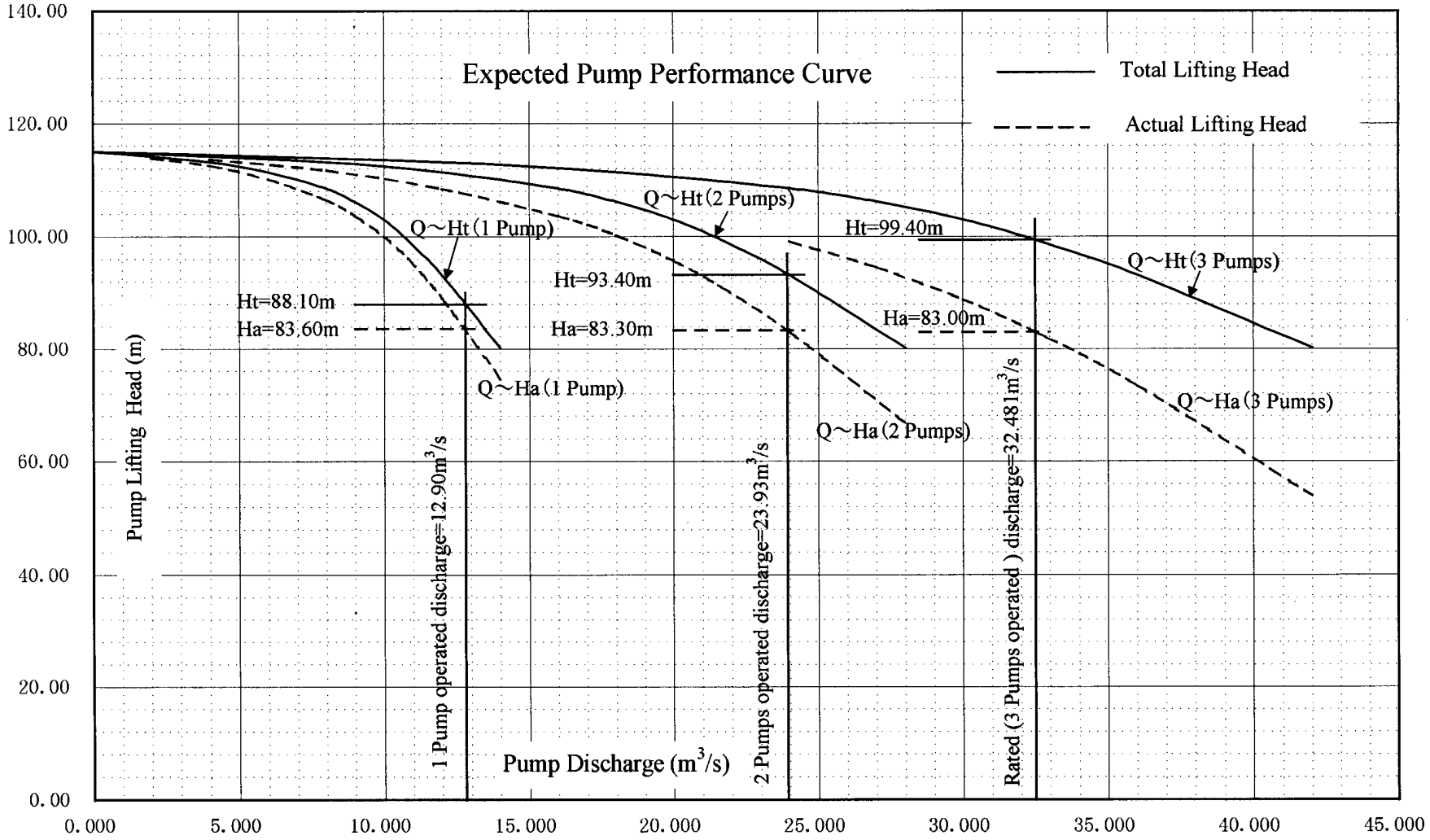


Figure 2.3-1 Expected Pump Performance Curve

(a) Effective Volume of Canal as Regulating Function

In order to clarify discrepancy inflow from the upper reach of conveyance canal and simulated discharge of No.7 PS, and allowable regulating water volume in the conveyance canal, the following study was carried out.

In the study, water level dropping limit from the proposed water supply level in each number of pump operation assumed 1 m taking into account safety of side slop of the open canal section. The effective volume as regulating function of the canal for on-off operation of the pumps is tabulated in the Table 2.3-5.

Table 2.3-5 Effective Volume of Regulating Function

Case	Discharge (m^3/s)	Fluctuation of water level (m)	Effective volume of regulating function (m^3)
1 unit operating	12.900	1.00	102,700
2 units operating	23.930	1.00	120,200
3 units operating	32.481	0.97	114,000

(b) Maximum Continuously Operating Hours of Pumps

Intermediate operation of No.7 SP shall be applied in order to adjust discrepancy between water requirement of each month and actual pump lifting capacity. The maximum continuously operating hours of pumps are shown in the Table 2.3-6.

Table 2.3-6 Maximum Continuously Operating Hours of Pumps

Month	Water Requirement (m^3/s)	Pump (unit)	Actual Discharge (m^3/s)	Differential Discharge (m^3/s)	Effective Volume (m^3)	Operating Hours (hr)
Jan.	13.70	2	23.930	10.23	120,200	3.26
Feb.	15.65	2	23.930	8.28	120,200	4.03
Mar.	17.36	2	23.930	6.57	120,200	5.08
Apr.	15.38	2	23.930	8.55	120,200	3.91
May	14.91	2	23.930	9.02	120,200	3.70
Jun.	22.96	2	23.930	0.97	120,200	34.42
Jul.	32.48	3	32.481	0.00	114,000	∞
Aug.	27.59	3	32.481	4.89	114,000	6.48
Sep.	15.38	2	23.930	8.55	120,200	3.91
Oct.	8.57	1	12.900	4.33	102,700	6.59
Nov.	8.09	1	12.900	4.81	102,700	5.93
Dec.	11.75	1	12.900	1.15	102,700	24.81

(c) Maximum Continuously Stopping Hours of Pumps

The maximum continuously stopping hours of pumps are shown in the Table 2.3-7.

Table 2.3-7 Maximum Continuously Stopping Hours of Pumps

Month	Water Requirement (m^3/s)	Pump (unit)	Actual Discharge (m^3/s)	Differential Discharge (m^3/s)	Effective Volume (m^3)	Stopping Hours (hr)
Jan.	13.70	1	12.900	0.80	120,200	41.74
Feb.	15.65	1	12.900	2.75	120,200	12.14
Mar.	17.36	1	12.900	4.46	120,200	7.49
Apr.	15.38	1	12.900	2.48	120,200	13.46
May	14.91	1	12.900	2.01	120,200	16.61
Jun.	22.96	1	12.900	10.06	120,200	3.32
Jul.	32.48	2	23.930	8.55	114,000	3.70
Aug.	27.59	2	23.930	3.66	114,000	8.65
Sep.	15.38	1	12.900	2.48	120,200	13.46
Oct.	8.57	0	0	8.57	102,700	3.33
Nov.	8.09	0	0	8.09	102,700	3.53
Dec.	11.75	0	0	11.75	102,700	2.43

(d) Operation Pattern of No.7 Pumping Plants

The monthly base operation patterns of the No.7 Pumping Station for Stage I, therefore, can be developed from the Table 2.3-4 as shown in the Table 2.3-8. Many operation pattern can be considered from the Table 2.3-4 and Table 2.3-7. Therefore, NSDO shall consider most appropriate operation plan as well as mobilization plan of staff based on the progress and requirement of the Project.

Table 2.3-8 Monthly Operating Pattern of No.7 Pumping Station (1/3)

Month	Water Req. (m^3/s)	Required Hours (hr/day)	No. of Pump (unit)	1st day				2nd day				3rd day				4th day			
				6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24
Jan.	13.70	25.74	No.1	■	■	■	■							■					
			No.2			■						■	■	■	■				
			No.3					■	■	■	■							■	
			No.4							■						■	■	■	■
Feb.	15.65	29.98	No.1	■	■	■	■		■						■				
			No.2		■						■					■	■	■	■
			No.3				■					■	■	■	■		■		
			No.4					■	■	■	■		■						■
Mar.	17.36	33.70	No.1	■	■	■	■		■						■				
			No.2		■						■					■	■	■	■
			No.3				■					■	■	■	■		■		
			No.4					■	■	■	■		■						■
Apr.	15.38	29.40	No.1	■	■	■	■						■				■		
			No.2		■				■			■	■	■	■				
			No.3				■				■					■	■	■	■
			No.4					■	■	■	■				■				■

Table 2.3-8 Monthly Operating Pattern of No.7 Pumping Station (2/3)

Month	Water Req. (m^3/s)	Required Hours (hr/day)	No. of Pump (unit)	1st day				2nd day				3rd day				4th day			
				6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24
May	14.91	28.37	No.1																
			No.2																
			No.3																
			No.4																
Jun.	22.96	45.89	No.1																
			No.2																
			No.3																
			No.4																
Jul.	32.48	72.00	No.1																
			No.2																
			No.3																
			No.4																
Aug.	27.59	58.27	No.1																
			No.2																
			No.3																
			No.4																

Table 2.3-8 Monthly Operating Pattern of No.7 Pumping Station (3/3)

Month	Water Req. (m^3/s)	Required Hours (hr/day)	No. of Pump (unit)	1st day				2nd day				3rd day				4th day			
				6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24
Sep.	15.38	29.40	No.1																
			No.2																
			No.3																
			No.4																
Oct.	8.57	15.94	No.1																
			No.2																
			No.3																
			No.4																
Nov.	8.09	15.05	No.1																
			No.2																
			No.3																
			No.4																
Dec.	11.75	21.86	No.1																
			No.2																
			No.3																
			No.4																

2.4 Practices of Operation and Maintenance

(1) Extrusion of Deposited Sand in the Sand Settling Basin

Deposited sand in the sand settling basin along open canal and box culvert canal shall be periodically demolished by manually and or using appropriate equipment to keep function of the conveyance canal.

On the other hand, extrusion of deposited sand of the sand settling basin in front of the No.7 PS shall be executed annual basis using heavy equipment recommended as follows ;

- Such maintenance works shall be carried out one basin by one basin alternately during pre-winter period from October to December.
- Dewatering before demolishing sand from basin using water filling pump (dia. 300mm x 200mm x 240kw) for pipeline. Dewatering time will be about 16 hrs (9,600m^3 x 1/600 m^3 /min up to the elevation of 4.40 m)
- In parallel with the dewatering (below 4.40m elevation) using small pump, demolishing deposited sand shall be carried out by using combination of tire type dozer-shovel (40 m^3 hr) and dump truck
- Sand soil volume for one basin is approx. 1,350 m^3 and operation time of demolishing work is estimated about 5 days (34 hrs).

(2) Maintenance of Earth Covered on Top of the Box Culvert and Steel Pipes

According to the detailed design conditions of the box culvert section and steel pipeline, allowable maximum earth cover on the top of the facilities is 5 meters. Standard cross section of the facilities, however, indicate that the earth cover depth including gravel pavement and clayey soil layer is one meter.

Box culvert section and steel pipeline route will pass through drift sand dune area. Periodical patrol of the subject canal routes, therefore, shall be undertaken by the maintenance staff to avoid over covering soil by the drift sand dune phenomenon. These demolishing works shall be executed together with ordinal maintenance works of the operation and maintenance road provided along the conveyance canal routes.

(3) Maintenance of Surge Tank Equipment and Other Instruments

Ordinary and periodical maintenance of the bi-plane check valves, surge tank equipment and cathodic protection devices shall be performed completely. Phenomenon of water hammer of the pumping plants and delivery pressured pipelines will occur as very rare cases. Because, power supply system of the project has a plan to receive electric power by two supply lines. It means that frequency of power failure is quite rare and sudden stop of

operation of the pumping plants is not common except miss operation and or troubles of appurtenant facilities and instruments like valves and surge tanks.

Therefore, the above mentioned facilities and equipment shall be carefully maintained by daily, monthly and or annually bases keeping well functional conditions based on the manners and instructions provided by the equipment suppliers and contractors.

CHAPTER 3 OPERATION AND MAINTENANCE EQUIPMENT

CHAPTER 3 OPERATION AND MAINTENANCE EQUIPMENT

3.1 Required Equipment

The following equipment will be required to execute appropriate operation and maintenance works for the water conveyance canal systems in addition to the ordinary equipment, instruments and spare parts provided from mechanical and electrical equipment suppliers.

Table 3.1-1 Equipment List of Operation and Maintenance

Category	Equipment and specification	Quantity	Utilization
Common	4WD vehicle (2,500cc)	4 units	One unit each for main office, pumping station, upper reach canal and lower reach
Common	Tele-communication system	1 unit	Main office, VHF radio communication system
Demolishing deposited sand	- Cramshell and crane ($0.30\ m^3$, 12ton crane)	2 units	Open canal and box culvert section
Ditto	- Wheel type loader ($1.50m^3$, 10 ton) - Dump truck (10 ton) - Submerged sand pump (200mm)	- 1 unit wheel type loader - 2 units dump truck - 4 units sand pump	Sand settling basin in front of No.7 PS
Maintenance of the access and OM roads	- Grader (14ton) - Bulldozer (15ton) - Backhoe ($0.6m^3$) - Dump truck (15 ton)	- 1 unit - 2 units - 2 units - 3 units	OM roads along the canal routes and access roads

3.2 Workshop of the Equipment

Workshop of the OM equipment locates vicinity of the No.7 pumping station to keep well conditions of equipment and instruments.

CHAPETER 4 ORGANIZATION AND STAFFING OF OPERATION AND MAINTENANCE

4.1 Proposed Organization

4.2 Staffing Plan

CHAPTER 4 ORGANIZATION AND STAFFING OF OPERATION AND MAINTENANCE

4.1 Proposed Organization

Under the existing Kantara NSDO office, following organization is proposed to undertake proper operation and maintenance activities and instruction to the beneficial farmers.

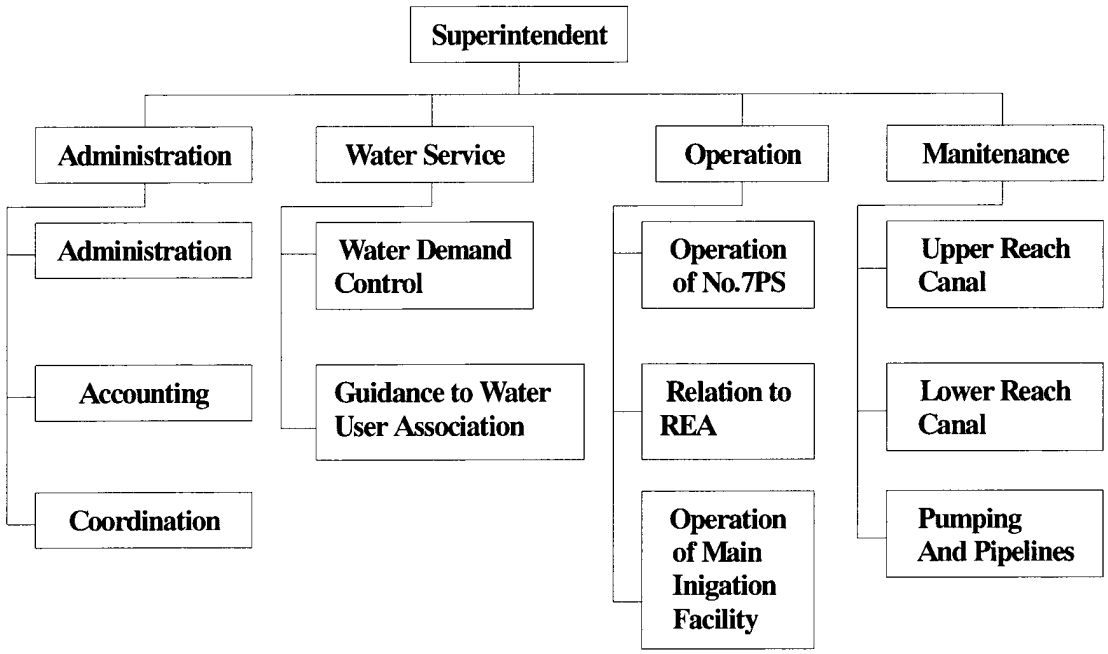


Figure 4.1-1 O/M Organization of El Sir & El Kawareer Area

4.2 Staffing Plan

Staffing plan of the operation and maintenance office of the El Sir & El Kawareer Project under
Kantara NSDO office is summarized as following Table 4.2-1

Operation and maintenance work for "Main Substation" will be executed by the REA (Rural Electrification Authority) organization. Therefore, numbers of the required staff for the Main Substation O/M are not included in the Table 4.2-1.

Table 4.2-1 Staffing Plan

Section	Staffing grade	Number of staff	Remarks
Superintendent	- General Manager	1	
Administration	- Chief of the section - Assistant director - Clerk	1 3 3	- Administration - Accounting - Coordination
Water Service	- Chief of the section - Assistant Director - Irrigation engineer - Clerks	1 2 1 2	- Water demand control - Guidance to WUA
Operation	- Chief of the section - Assistant Director - Engineer(Mechanical / Electrical) - Technician - Clerks	1 3 5 10 4	- Operation of No.7 PS - Relation and coordination to REA - Operation of main irrigation facility
Maintenance	- Chief of the section - Assistant Director - Irrigation engineer - Engineer(Mechanical / Electrical) - Technician - Clerks	1 3 1 3 30 3	- Upper reach canal - Pumping station and pipelines - Lower reach canal
Total	**- General Director** **- Chief of the section** **- Assistant Director** **- Irrigation engineer** **- Engineer** **- Technician** **- Clerk** **- Total**	**1** **4** **11** **2** **8** **40** **12** **78**	

CHAPTER 5 OPERATION AND MAINTENANCE COST

CHAPTER 5 OPERATION AND MAINTENANCE COST

5.1 Cost Components

In general, O/M costs for the El Sir & El Kawareer area shall be estimated not only the main water conveyance systems but also irrigation and drainage facilities and on-farm level facilities. Furthermore, some part of energy cost for No.1 to No.6 PS shall be included into the cost for the project.

The cost indicated in the report, however, only incorporated O/M costs for conveyance canal of 46 km including No7.PS. The cost items consist of salary and wages, energy cost of No.7 main pumping station and maintenance cost of overall conveyance canal systems for 46 km long.

5.2 Operation and Maintenance Cost

(1) Salary and Wages including Office Consumable Costs

Preliminary estimates of the salary of the officers, skilled and unskilled labor wages, and office consumable cost are tabulated as following Table 5.2-1.

Table 5.2-1 Salary and Labor Wages (Unit : 1,000LE)

Category	Number of staff	Unit cost/yr	Amount	Remarks
General Director	1	150	150	
Chief of the Section	4	120	480	
Assistant Director	11	96	1,056	
Irrigation Engineer	2	96	192	
Engineer(Mech/Elec)	8	96	768	
Technician	40	48	1,920	
Clerk	12	24	288	
Sub-total			4,854	
Consumable Cost	1 L.S.		60	
Total			4,914	

(2) Energy Cost of No.7 Pumping Station

Accumulated main pump operation hours for each month and energy cost are tabulated as following Table 5.2-2.

Table 5.2-2 Energy Cost of No.7 Pumping Station

Month	Average daily operation hours	Days of the month	Amount	Remarks
January	25.74	31	797.94	
February	29.98	28	839.44	
March	33.70	31	1,044.70	
April	29.40	30	882.00	
May	28.37	31	879.47	
June	45.89	30	1,376.70	
July	72.00	31	2,232.00	
August	58.27	31	1,806.37	
September	29.40	30	882.00	
October	15.94	31	494.14	
November	15.05	30	451.50	
December	21.86	31	677.66	
Total			12,363.92	

The annual energy costs, therefore, will be about 32.1 Million Pounds for 161 MWH.
(12,364 hrs/yr x 13,000 kw x 0.2 LE/kw = LE 32,146,000)

(3) Total Annual O/M Cost

Total operation and maintenance cost for Stage I is about 37 million pounds.

5.3 Procurement of O/M Equipment Cost

Preliminary cost estimates of the O/M equipment are summarized as following Table 5.3-1.

Table 5.3-1 Cost Summary of O/M Equipment (Unit : LE)

Equipment	No. of Unit	Unit Cost	Amount	Remarks
4WD vehicle (2,500cc)	4	360,000	1,440,000	
Cramshell (0.30m^3, 10ton)	2	320,000	640,000	
Wheel loader(1.50m^3,10ton)	1	410,000	410,000	
Dump truck (10ton)	2	380,000	760,000	
Dump truck (15ton)	3	580,000	1,740,000	
Grader (14ton)	1	570,000	570,000	
Bulldozer (15ton)	2	550,000	1,100,000	
Backhoe (0.60m^3)	2	580,000	1,160,000	
Submerged pump (200mm)	4	85,000	340,000	
VHF	1		500,000	
Total			**8,660,000**	