No. 52

THE ARAB REPUBLIC OF EGYPT

FAYOUM GOVERNORATE

FEASIBILITY REPORT

ON

FAYOUM AGRICULTURAL DEVELOPMENT PROJECT

APPENDIX-I
APPENDICES-A,B,C,D & E

MARCH 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

A F T
CR(3)
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APPENDIX–I

ABBREVIATION AND GLOSSARY

ABBREVIATION

AOF	Agricultural Office in Fayoum, MOA
ARC	Agricultural Research Center
ARE	Arab Republic of Egypt
COF	Agricultural Cooperative Office in Fayoum
DOB	Drainage Office in Beni Suef
EIRR	Economic Internal Rate of Return
ESD	Egypt Survey Department
Ez	Ezba Hamlet or Small Village
FAF	Faculty of Agriculture in Fayoum, Cairo Univ.
FGC	Fayoum Geological Center
FIRR	Financial Internal Rate of Return
FSA	Farmer Social Association
GARPAD	General Authority for Rehabilitation Project and Agricultural Development
GOE	Government of Egypt
GOF	Governorate of Fayoum
GOJ	Government of Japan
IBRD	International Bank of Reconstruction & Development
IDF	Irrigation Department, Fayoum
IOF	Irrigation Office in Fayoum, MOI
JICA	Japan International Cooperation Agency
LE	Egyptian Pound
MOA	Ministry of Agriculture and Food Security
MOI	Ministry of Irrigation
MOPIC	Ministry of Planning and International Cooperation
MORCL	Ministry of Reconstruction, New Communities and Land Reclamation
O&M	Operation and Maintenance
OECF	The Overseas Economic Cooperation Fund
SSD	Soil Survey Department
UNDP	United National Development Program
USAID	US Agency for International Development
¥	Japanese Yen

UNIT

Length

mm	millimeter(s)
cm	centimeter(s)
m	meter(s)
km	kilometer(s)

Area

sq.m	square meter(s)
sq.km	square kilometer(s)
Fed. or feddan	local unit of acreage = 4,200 sq.m = 0.42 ha
ha	hectare = 2.381 feddan

Weight

mg	milligram(g)
g or gr	gram(s) = 1,000 mg
kg	kilogram(s) = 1,000 g
ton	ton(s) = 1,000 kg

Time

sec	second(s)
min	minute(s)
hr	hour(s)

Content

lit.	liter(s)
cu.cm	cubic centimeter(s)
cu.m	cubic meter(s)
MCM	million cubic meter(s) = 1,000,000 cu.m

Velocity

cm/sec	centimeter(s) per second
m/sec	meter(s) per second
km/sec	kilometer(s) per second

Discharge

lit/sec	liter(s) per second
cu.m/sec	cubic meter per second

Others

V	volt(s)
KVA	kilovolt ampere(s)
KW	kilowatt(s)
KWH	kilowatt(s) hour
Hz	hertz(s)
ps	Pferdestärke = horse power(s)
ppm	part(s) per million
mmhos	millimhos unit for electric conductivity
°C	centigrade degree(s)

CONVERSION TABLE

Metric Cantar	Cotton (Unginned)	157.5 kg
	(Ginned or lint)	50.0 "
Cantar	Other Crops	44.9 "
Ardeb	Wheat	150.0 "
	Maize	140.0 "
	Sorghum	140.0 "
	Millet	140.0 "
	Barley	120.0 "
	Sesame	120.0 "
	Rice (Unhusked)	300.0 "
	Rice (Bleached)	200.0 "
	Beans	155.0 "
	Beans (Crushed)	144.0 "
	Lentiles	160.0 "
	Lentiles (Crushed)	148.0 "
	Grounduts	75.0 "
Dariba	Rice (Unhusked)	933.0 "
	Rice (Bleached)	630.0 "

CURRENCIES

LE	1	=	US$	1.22
US$	1	=	LE	0.82
US$	1	=	¥	240
LE	1	=	¥	290

FISCAL YEAR

JULY to JUNE

APPENDIX A.

GENERAL

Appendix A. GENERAL

LIST OF TABLES

APPENDIX A. GENERAL

A-1. List of Cooperators

A-1.1. List of Cooperators During the First Field Survey

Name	Position
H.E. General Tharwat Attallah	Governor, Fayoum Governorate
Eng. Mohammed Fouad Sobeih	General Director, Ministry of Irrigation, Fayoum (MOI,F)
Eng. Hamdy Kotb Metwalli	Inspector, MOI,F
Eng. Galal Youssef Khateery	Inspector of Eastern Area, MOI,F
Eng. Adieb Fauzy Tawfic	Inspector of Western Area, MOI,F
Eng. Samir Ibrahim Shobair	Director of Works, MOI,F
Eng. Samir Ibrahim Jacob	Director of Works for Eastern Area, MOI,F
Eng. Hamdy Mohamed Abdulla Mergaban	In charge of Water Information, Western Area, MOI,F
Eng. Moustafa Meneisey	Asst. Director of Works for Western Area, MOI,F
Eng. Sayed Ahmed Salah	Irrigation Engineer of Tamiah District, MOI,F
Eng. Mahammed Saadiwa Hassan	Head of Mechanical Section, MOI,F
Mr. Hans Van Leevwen	Team Leader of Dutch Drainage Research Team (DDRT)
Mr. Wouter Walters	Associate Expert, DDRT
Mr. Mohammed Eisa	Counterpart, DDRT
Mr. Charles Lugt	Project Manager, Olive and Mango Multiplication Project
Mr. Mohamed Ahmed Saied	Vice Director, Land Reform Directorate in Fayoum (LRD)

Name	Position
Eng. Mohamed Ahmed Ibrahim	Chief Engineer, LRD
Eng. Ezab Azab El Allah	Director of Land Reform Abshway Office, LRD
Dr. Ibrahim Anter	Director, Institute for Water and Soil Investigation (IWSI)
Mr. Said Abd El Gawad	Director of Soil Analysis, IWSI
Mr. Abd El Ghani Abo Gleil	Researcher of Fayoum Area, IWSI
Mr. Fekry El Baghatadi	Head of Soil Survey, IWSI
Dr. Saad Nossar	Dean of Faculty of Agriculture, Fayoum (FAF), Cairo University
Dr. Mahmoud Abd Elgawad	Head of Soil and Water, FAF
Dr. Mahmed Hammed	Associate Professor, FAF
Dr. Mohamed Fauzy Kamel	Director, Veterinary Dept.
Dr. Mohamed Hendi	Veterinary Dept.
Mr. Abdel Hadi Ahmed	Head of Economic Development
Mr. Bouchra Latif Dawood	Agronomist
Mr. Tarif Abd El Raouf Mohamed	Department of Agri-cooperatives
Dr. Sayed Mahmoud Ali	Director of Fayoum Veterinary Office
Dr. Yassin Osman	Director, Ministry of Agriculture, Fayoum
Mr. Mahamed Dweidar	Director of Agriculture
Mr. Saleh Fahim Bishay	Director of Fishery Dept.
Dr. Ragaie Fahmey Dawood	Veterinary Dept.
Dr. Fahmy El Gamal	Head of Hydrobiologic Station, Qarun
Mr. Mohsen Abd El Fatah	Fayoum Agricultural School

Name	Position
Mr. Rahea Gamda Elsayed	Director, Tamiah Branch Station of Agricultural Research Center
Mr. Mohamed Hammad Atio Shakweer	Associate Professor of Land Reclamation
Mr. Abo Bakr Abdel Nasser	General Director of Dept. of Agricultural Cooperatives
Mr. Tarif Abdel Raoub	Dept. of Agricultural Cooperatives
Mrs. Traiza Grgies	Dept. of Statistics, Fayoum Governorate
Mr. Aziz Hamdi	General Manager of Agri. Development Bank, Fayoum
Mr. Mohamed Sabat	General Manager of Agri. Development Bank, Fayoum
Mr. Slah Manaa	Director of Agri. Development Bank, Fayoum
Eng. Fakkery Moahtar	Chief Mining Engineer, Fayoum Geological Center (FGC)
Eng. Rifai Ebrahim Aifai	Chief Geologist, FGC
Mr. Salah Helmi Fahmi	Governor of Tamiah District
Mr. Awad Woussef	Chief of Fayoum Meteorological Station
Mr. Samir Shafick Farag	Observer of Fayoum Station
Eng. Mohammed Sharpi El Segeed	Fayoum Governorate Workshop
Mr. Abd El Hakam Roly	Chief of Account, Fayoum Governorate Workshop
Eng. Salah Elden Ibrahim Ablata	Manager of Fayoum Governorate Workshop
Mr. Ismaiel Abd El Wahah	Fayoum Shakshok Police of Lake Qarun
Mr. Ashraf Salah El Din	Fayoum Shakshok Police of Lake Qarun

Name	Position
Mr. Mohamed Eihaf Baker	Fayoum Shakshok Police of Lake Qarun
Eng. Abdel Rahman Abdullah	Director of Fayoum Water Supply Authority
Eng. Mohamed El Sohagy	Director of Fayoum Electric Company

A-1.2. List of Cooperators During the Second Field Survey

Name	Assignment
H.E. General Tharwat Attallah	Governor, Fayoum Governorate
Eng. Salah Shehab	First Under-secretary, Ministry of Irrigation (MOI)
Eng. Helmy Mohamoud Ibrahim	Under-secretary for Horizontal Expansion, MOI
Eng. Abu Azizi Amin	Under-secretary of Water Management, MOI
Eng. Nady Selim	Under-secretary of Stage, Ministry of Irrigation, Fayoum (MOI,F)
Eng. Mohammed Fouad Sobeih	General Director, MOI,F
Eng. Hamdy Kotb Metwalli	Inspector, MOI,F
Eng. Samir Ibrahim Shobair	Director of Works, MOI,F
Eng. Samir Ibrahim Jacob	Director of Works for Eastern Area, MOI,F
Eng. Hamdy Mohamed Abdulla Mergaban	Officer in Charge of Water Information, MOI,F
Eng. Mahammed Saadiwa Hassan	Head of Mechanical Section, MOI,F
Dr. Kamal Hefny	Director, Underground Water Research Institute
Dr. Mohmound Abu Zeid	Chairman, Research Institute
Mr. Hans Van Leevwen	Team Leader of Dutch Drainage Research Team (DDRT)
Mr. Wouter Walters	Associate Expert, DDRT
Mr. Mohammed Eisa	Counterpart, DDRT
Dr. Samir R. Nagmoush	Technical Council, General Authority for Rehabilitation Projects and Agricultural Development (GARPAD)
Dr. Rifky Anwar	Consultant, GARPAD

Name	Assignment
Mr. Reda Heuien El Bhrawi	Manager, Soil Department, GARPAD
Eng. Said Abd El Naby	Engineer in Charge of Execution, GARPAD
Eng. Ragaei Aziz Salama	Manager of Irrigation Department, GARPAD
Eng. Yousery Wisia	Irrigation and Drainage Department, GARPAD
Mr. Saad Mohamed Bayoumy	Director General, Ministry of Planning and International Cooperation
Dr. Yassin Osman	Director, Ministry of Agriculture (MOA), Fayoum
Eng. Essan Salama	Agronomy, MOA, Fayoum
Dr. Mohamed Hendi	Veterinary Dept., MOA, Fayoum
Dr. Sayed Mahmoud Ali	Director of Fayoum Veterinary Office
Eng. Galal Gholam	Soil, MOA, Fayoum
Eng. Mohamed Mahmoud	Soil, MOA, Fayoum
Dr. Amin Mashaly	EALIP of MOA
Dr. Ibrahim Anter	Director, Institute for Water and Soil Investigation (IWSI)
Mr. Ferky El Bougdady	Deputy,(IWSI)
Mr. Sayed Moawad Mohamed	Inspector of Property Department, Fayoum Governorate
Mr. Azmy Abu Hussein	Chairman, Execution of Soil Improvement
Eng. Abd El Rahman Abdullah	Director, Fayoum Water Supply Authority
Dr. Saad Nassar	Dean of Faculty of Agriculture, Fayoum (FAF), Cairo University
Dr. Mahmoud Abd El Gawad	Head of Soil and Water, FAF
Dr. Mahmed Hammed Atia El Shakweer	Associate Professor of Land Reclamation, FAF
Dr. Sayed Khater	Associate Professor of Soil Survey & Classification, FAF

Name	Assignment
Dr. Ibrahim M. El Samanoudy	Lecture, Soil Physics, FAF
Mr. Mohamoud Mohamed Shendi	Doctor Course, FAF
Mr. Ehab Abd El Haleem El Sayed	Doctor Course, FAF
Mr. Mahoud Abd El Tawab	Student, Faculty of Education, Fayoum (EFF)
Mr. Aly Abdel Tawab	Student, FEF
Mr. Aziz Hamdi	General Manager of Agricultural Development Bank, Fayoum
Eng. Mohamed El Zany	Geologist, Brick Factory
Mrs. Eman El Masry	Secretary to the Study Team

A-1.3. List of Cooperators During Draft Final Report Explanation Mission

Ministry of Planning and International Cooperation (MOPIC)

Dr. Fouad Iskandar	First Under-secretary of State for International Economic Cooperation with Asiatic Countries
Mr. Mohsen Mohammed Sadek	Economic Research Section

General Authority for Rehabilitation Project and Agricultural Development (GARPAD)

Dr. Samir R. Nagmoush	Under-secretary of State for Research and Soil Studies
Dr. Rifky Anwar	Consultant of GARPAD
Eng. Badr Hafez	General Manager of Experimental Development and Project Preparation Unit
Eng. Hassan Abd El Nasr	General Director of Under Irrigation System
Agri. Eng. Mohamed M. Fatahallah	Director of Agriculture Section Project Preparation Unit

Ministry of Irrigation (MOI)

Eng. Salah Shehab	First Under-secretary of MOI
Eng. Helmy Mahmoud Ibrahim	Under-secretary of State for Horizontal Expansion Projects

Fayoum Governorate

H.E. Gen. Tharwat Attallah	Governor of Fayoum Governorate
Mr. Gamal El Din El Hefnawi	Secretary General
Mr. Ahmad Khalaf	Asst. Secretary General
Mrs. Abla A. Marzauk	Manager

Manistry of Agriculture, Fayoum

Eng. Essam Salam	Asst. General Director of Agricultural Department

Mr. Mohamed Dweder	Director of Agriculture Affairs
Dr. El Nabil Mikhail Rizkallah	Assistant of Veterinary Director

<u>Ministry of Irrigation, Fayoum</u>

Eng. Nady Selim	Under-secretary of State for Ministry of Irrigation, Fayoum
Eng. Hamdy Kotb Metwalli	Director General
Eng. Samir Ibrahim Shobair	Inspector of Eastern Area
Eng. Samir Ibrahim Jacob	Director of Works, Eastern Area

Appendix A-2. Social Economy

Table A2-1 Index Numbers of National Income (at current price)

	1975	1976	1977	1978	1979	80/81
Agriculture:						
Index	100	119	139	156	172	233
Growth rate		+19	+17	+12	+10	+36
Industry:						
Index	100	112	126	149	186	242
Growth rate		+12	+13	+18	+25	+30

Table A2-2 Development of Income (at current price)

(Unit: LE million)

No.	1975		1980/81	
1	Agriculture	1468	Agriculture	3427
2	Ohter services	982	Petroleum	3105
3	Industry	888	Finance & trade	2498
4	Finance & trade	777	Other services	2206
5	Transporation	258	Industry	2144

Table A2-3 Annual Growth Rate Imported Value

(Unit: %)

Item	1977/86	78/77	79/78	70/79	81/80
Vegetable products	-2.5	+36.8	-1.7	+51.2	+110.2
Living animals and its products	+39.9	+73.3	+15.3	+91.6	+98.6

Table A2-4 Comparison of Yield (1871)

(Unit: %)

	Raw Cotton	Summer rice	Nili rice	Summer millet	Nili millet	Summer maize	Nili maize
Fayoum/Egypt	81	92	39	88	66	89	89

Note: The original data are statistical indicators, 1981.

Table A2-5 Annual Growth of Household and Popuration

		1960 to 1966	1966 to 1976
Fayoum :	Household	0.9%	1.2%
	Poputation	1.8	2.0
Nationwide	Household	1.7	2.0
	Population	2.3	2.0

Note : The annual growth rate of the nationwide are calculated based on the Statistics, 1981.

1960-1966	2.5%	(Pupulation census)
1966-1976	2.3	(-ditto-)
1977-1978	2.5	(Preliminary)
1978-1979	3.1	(-ditto-)
1979-1980	3.2	(-ditto-)
1980-1981	2.8	(-ditto-)

Source : Statistical Indicator (1952-1979), July, 1980

Table A2-6 Population in Fayoum

Year	Population	Annual Growth Rate
1960	839,163	
		) 1.8%
1966	935,281	
		) 1.9
1970	1,008,000	
		) 2.1
1976	1,141,879	
		) 2.9
1980	1,273,450	

Source : Statistical Yearbook, Fayoum Governarate, 1981

Table A2-7 Population Density

	Land area (sq.km)	Population (1976)	Density (p/sq.km)	Population (1981)	Density (P/sq.km)
Fayoum City	12.79	166,910	13,050	190,561	14,899
Fayoum District	307.18	169,590	552	196,437	639
Ibschway	436.89	257,027	500	302,298	692
Etsa	481.36	217,155	401	249,012	517
Sennoris	243.21	194,288	790	220,459	906
Tamiah	345.15	136,909	396	157,655	456
Total	1,827.15	1,141,879	620	1,316,422	720

Source : Statistical Yearbook, Fayoum Gavernarate, 1981

Table A2-8 Urban and Rural Population and Annual Growth Rate

	Total			Urban			Rural		
	1960	1966	1976	1960	1966	1976	1960	1966	1976
Fayoum	839 (100)	935 (100)	1,142 (100)	162 (19.3)	200 (21.4)	275 (24.1)	677 (80.7)	735 (78.6)	867 (75.9)
Cairo	3,349 (100)	4,220 (100)	5,074 (100)	3,349 (100)	4,220 (100)	5,074 (100)	- (-)	(-)	(-)
Nationwide	26,074 (100)	29,942 (100)	36,626 (100)	9,864 (37.8)	12,140 (40.5)	16,036 (43.8)	16,210 (62.2)	17,802 (59.5)	20,590 (56.2)
- Growth Rate -									
Fayoum 1960/1966		1.8 %			3.6 %			1.4 %	
1966/1970		2.0 %			3.2 %			1.7 %	

Note : Excluding nomads in frontier governarates.

Source : Statistical Indicators (1952-1979), July, 1980
Central Agency for puplic Nobilization & Statistics

Table A2-9 Population of Fayoum in 1976

	No. of City	No. of Village	No. of Local Unit	Population Urban	Population Rural	Population Total
Fayoum	1	-	-	166,910	-	166,910
Fayoum District	-	38	9	-	169,590	169,590
Sennouris	1	24	6	42,010	152,278	194,288
Ibschway	1	31	8	26,616	230,411	257,027
Etsa	1	46	9	20,171	196,984	217,155
Tamaih	1	18	5	19,671	117,238	136,909
Total	5	157	37	275,378	866,501	1,141,879

Note : Statistical Year Book, Fayoum Governarate, 1981.

Table A2-10 Population per Household in Fayoum

	1960	1966	1976
No. of Household	185,587	195,806	220,697
Pupulation ('000)	839	935	1,142
Population per Household	4.5	4.8	5.2

Source : Statistical Year book, Fayoum Gavernarate, 1981

Table A2-11 Structure of Employment in 1976

(Unit: %)

	Fayoum City	Fayoum District	Ibschway	Etsa	Sennoris	Tamaih	Total
Technical jobs	15.5	2.1	1.8	2.4	3.4	1.5	4.3
Manager	2.3	0.2	0.2	0.2	0.3	0.3	0.6
Clerk	11.7	1.9	1.5	1.7	2.4	1.7	3.4
Selling	10.6	3.1	5.8	3.7	6.2	3.7	5.6
Services	11.0	6.7	4.3	4.6	5.9	4.2	6.0
Agri., Animal & Fishary	10.6	73.2	76.4	77.5	63.4	81.2	64.2
Industry & Transport	30.5	10.7	7.9	6.5	13.2	5.8	12.2
Others	7.8	2.1	2.1	3.4	5.2	1.6	3.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Employment	45.7	46.1	46.5	43.4	43.9	46.7	45.3
Unemployment	54.3	53.9	53.5	56.6	56.1	53.3	54.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

APPENDIX B.

METEOROLOGY AND HYDROLOGY

APPENDIX B. METEOROLOGY AND HYDROLOGY

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APPENDIX B. METEOROLOGY AND HYDROLOGY

B-1. Meteorological Conditions

B-1.1. Existing Meteorological Stations

(1) Location

There are two observatories in the Fayoum depression, namely, Fayoum Station under the Meteorology Department and Shakshok Station under Drainage Research Institute (DRI), Ministry of Irrigation (MOI).

The former station is located at 29 degrees 18 minutes north latitude, 30 degrees 51 minutes east longitude and 23 m above the mean sea level (MSL) altitude in the Fayoum urban area, and is about 30 km far from the Project Area. The latter one exists at the lake shore of Lake Qarun with a latitude of 29°28' north, a longitude of 30°42' east and 43 m below MSL, and is located at nearby the South Area of Lake Qarun which is one of the Project Area. The Figure B1-1 expresses the location of these observatories.

(2) Observed Items

The both observatories have almost same observed items which are maximum and minimum temperatures, relative humidity, rainfall, wind speed and directions, and vapor pressure. The Fayoum station is observing temperatures in the earth in addition to above items. At the another station, evaporation rates under the various conditions such as different size of an evaporation pan and kinds of water, and water levels of Lake Qarun are additionally observed.

B-1.2. New Azba Meteorological Station

(1) Location

The Azba station was established by the study team of JICA in March 1984. The latitudinal and longitudinal locations and altitude are 29°23N, 39°59E, and 13.7 meters above MSL, respectively. (refer to Fig.B1-1)

(2) Observation Items

This station is equipped with an automatic (self-recording) thermometer and hydrometer, automatic wind vane and anemometer, and automatic evaporation recorder with Pan "A". The observed data have been recorded since the last decade of March 1984. The specification of the above equipments is described in the Table B1-1.

(3) Other Note

Regarding to the automatic thermometer in the Azba station, the originally printed scale of the recording paper was adjusted at 10:00 AM on 30th of July, 1984. The adjusted range is 10°C plus the original scale. Since the actual temperature will be expected over 40°C which is the maximum scale of the original paper and the minimum temperature will not reach below minus 10°C (-10°C), the recording scale is adjusted. Therefore, the user of the recorded data should pay more attentions to the above matter. If the temperature will be expected exceeding 50°C, the adjusting knob which is attached on the back of the instruments should be adjusted with an accurate thermometer.

Regarding to the automatic recorder of wind speed and direction, the observation range also changed for from the instant values to the mean values at 10:00 AM on 6th of August, 1984. The mean values indicates in average for ten minutes, which is before and after five minutes on the center of a indicated time. If the instant values will be useful for the future study, the observed range shall be changed by the switch which is attached at the right side of the front panel on the instruments.

B-1.3. Meteorological Data in Fayoum

The meteorological data in Fayoum are presently available only at the stations mentioned before. The both Fayoum and Shakshok stations are available from 1931 up to now. The new station of Azba can supply meteorological data from March, 1984.

B1-4. Meteorological Conditions

As known well, the Project Area belongs to the arid zone. Therefore, the meteorological data show several special features such as low humidity, large diurnal range, and small amount of rainfall.

(1) Temperature

At the Shakshok station, the annual mean, maximum mean, and minimum mean temperature are 22.2°C, 28.6°C, and 15.7°C, respectively. The hottest month comes in July or August. The mean temperature arrives at nearly 30°C in these months. The coldest is in January with the minimum temperature of 6.3°C. According to the comparison of these data, Azba station records slightly higher temperatures than Shakshok station since the former is affected by the desert climate while the Shakshok station by cool air from Lake Qarun. (refer to Table B1-4).

The maximum mean temperature of 29°C at the Fayoum station is slightly higher than that at the Shakshok station and the minimum one of 14.5°C is lower because the Fayoum station is located far from the Lake and is not influenced by the Lake. So the bigger diurnal range appears. (refer to Tables B1-2 and B1-3)

(2) Rainfall

The annual amount of rainfall is negligibly small at 9.2 millimeters at the Shakshok station. This small amount of rainfall takes place in winter season from October to March. However, the daily maximum rainfall was recorded at 16 millimeters. The Fayoum station indicates almost same trend in rainfall. However, the extreme value of the maximum daily rainfall of 44 mm/day was recorded. The rainfall is a typical tropical concentrate (squall type) rainfall but a consecutive time of rainfall is short within 30 minutes. (refer to Table B1-2)

(3) Humidity

At the Shakshok station, the monthly fluctuation of mean relative humidity is not so big. The annual mean value of relative humidity is 61 percent. In winter season from November to February, the value is 67 percent, which is slightly higher than the annual mean. In the summer season from May to August, it is 57 percent, which is lower than the mean value. (refer to Table B1-2)

On the other hand, the records at the Fayoum station expressed a little bit difference compare with the data in Shakshok. During the summer season from May to September the monthly mean humidity ranges from 35 percent to 46 percent and in the winter season from November to January it is nearly 62 percent. (refer to Table B1-3)

As compared with data observed by the automatic recorder at the Azba station, the Shakshok station records higher values of 60.5 percent in annually since the Azba station is located near a desert area.

The data at the Fayoum station indicate the almost same values of 49.9 percent in annual at the Azba station because the station is located at far from the Lake. (refer to Table B1-5)

The automatic records of relative humidity shows an inverse proportional relation with temperatures on the recording paper. Since no climatorological elements such as rainfall, etc., do not affect the relative humidity at the Azba station, the relation is very clear. Consequently, the maximum relative humidity appears at the same time when the minimum temperature takes place before sunrise, and the minimum relative humidity is observed at the same time when the maximum temperature is recorded. It is usually at 2:00 to 4:00 p.m. (refer to Fig. B1-2)

(4) Wind speed and Direction

The annual mean wind speed of 2.5 m/sec was recorded at the Shakshok station. The monthly variation shows the same tendency as the monthly mean relative humidity. In May and June the monthly mean wind speed of 3.17 m/sec is observed and in December to February of 1.7 m/sec. The anemometer height at the station is 15 meters above the ground level. (refer to Table B1-2)

Data recorded by the automatic anemometer at the Azba station show that the maximum instant wind speed reached ten m/sec. The most frequent wind directions are north to north-east.

The monthly value of wind speed is a little bit bigger than that of the other two observatories. However, the difference between both stations is not so big. (refer to Table B1-6)

(5) Evaporation

Various daily evaporation rates by sizes of pan and pond and a kinds of water are observed. All the evaporation data show the same trend that in the winter season. The evaporation rate ranges from three to six millimeters per day, and in the summer season the rate increases to about 12 millimeters per day. The annual evaporation with a class "A" Pans filled with fresh water and with salt water, and a pond scaled 12 meters by ten meters filled with lake water are 2,952, 2,701, and 1,934 millimeters, respectively.

At the Azba station, the monthly evaporation rates from March to September varies from five to 12 millimeters. The maximum value of monthly mean evaporation rate of 12 mm/day appeared on June. The daily maximum evaporation reached 15 mm/day.
(refer to Table B1-7 and Fig. B1-3)

(6) Consideration of Operation and Maintenance Works of Gauges

To collect good data, the following items should be kept;

* To adjust time, and check instruments;
* To check instruments every two weeks;
* To clean instruments to remove small dust and sand;
* To repair the fence of the meteorological station;
* To maintain the recording pen in good condition;
* To write some items such as data, time and remarks on the recording paper when O & M works were done.
* To full water in the evaporation pan to five centimeters below the top of the evaporation pan wall on every Saturday and
* To change the recording paper under the right way or the correct way.

Table B1-1 Location of Stations and Specification of Instruments

1. Meteorological Station

1.1. Location

Azba village, Tamiah, Fayoum

1.2. Specification

1) Automatic Combination Anemometer

Model Type	:	Dyna Vane Type, Ohta Model No.111-T
Wind Speed		
Scale	:	2 to 35 m/s
Accuracy	:	+ 0.5 m/s below 10 m/s + 5% above 10 m/s
Wind Direction		
Scale	:	16 cardinal points with 540° shift
Accuracy	:	Less than 5°
Power		1.5 V dry battery x 1 and 12V DC battery x 1

2) Automatic Evaporation Recorder

Model Type	:	Ikeda EVP-1, Class "A" Pan, Ikeda Keiki
Measuring range	:	0 to 100 mm
Accuracy	:	+ 1 mm
Evaporimeter	:	1,200 mm in diameter
Power	:	1.5 V dry battery

3) Automatic Recording Thermo-Hygrograph Meter

Model No.	:	Ohta Model No.114
Temperature		
Sensor	:	Aged bimetallic strip
Accuracy	:	± 1 %
Scale	:	-20°C to 40°C
Humidity		
Sensor	:	Human hair bounden
Accuracy	:	+ 2.5% between 20 and 80%, 3% at extremes
Sensitivity	:	1%
Power	:	1.5V dry battery

4) Salinity Recorder

Measuring range	:	0.2 to 2 %, accuracy ± 3 %
Indicate items	:	Salinity and time
Recorder	:	Impact dot matrix method
Record item	:	Time (day, hour and min), salinity, and battery power source (print at every 0:00)
Sampling interval	:	Automatic A- Every hour or B- Every 12 hour at 6 and 18:00 Hand-operating (Anytime)
Power Source	:	External battery DC 12 Volt Working range 9 to 15 Volt Power requirement 50mA Working of recorder 1200mA
Durability	:	About two (2) weeks
Operating condition	:	Sensor 0 to 50 °C Indicator 0 to 50 °C
Water pressure resistance of sensor	:	More than 30 kg/sq.cm

2. Water Level Gauging Stations

2.1. Location

(1) Shakshok for Lake Qarun

(2) Casr Rashuwan on Batts Drain

(3) Gerza on Bahr Wahby

(4) Intake point of Bahr Green of Bahr Wahby

(5) Diversion point of Com Osheem canal from Bahr Wahby

2.2. Specification

Model Type	:	Ohta Model No.116-II
Full scale span	:	0 to 10 meters
Chart scale division	:	20 mm - 1 meter water level change
Accuracy	:	1% in full scale

Table B1-2 Climatorological Condition at Shakshok
(Year 1931-1960)

Location: Lat. 29°28'N Langit. 30°42'E

Month	Temperature Max. (°C)	Temperature Min. (°C)	Temperature Mean(1) (°C)	Relative Humidity(2) (%)	Rainfall Mean (mm)	Rainfall Max.(3) (mm)	Mean(4) Wind Speed (m/sec)	Remark
Jan.	19.2	6.3	12.8	68.7	0.5	3.5	1.55	(1) Mean temp. =(Max.+ Min.)/2
Feb.	21.0	7.6	14.3	65.3	1.6	9.0	2.01	
Mar.	24.3	10.8	17.6	59.3	1.1	11.5	2.63	(2) Relative Humidity is the
Apr.	28.6	14.5	21.6	54.7	0.8	14.0	2.78	mean value of data observed
May	32.5	18.8	25.6	52.0	0.7	16.0	3.09	at 6:00, 12:00 and 18:00
Jun.	34.7	21.4	28.0	53.3	0.0	-	3.24	(3) The Max. Rainfall had been
Jul.	36.6	22.7	29.6	54.7	0.0	-	2.78	occurred in the past years.
Aug.	36.7	23.2	30.0	56.3	0.0	-	2.63	(4) The original data are
Sep.	33.4	21.6	27.5	61.0	0.0	-	3.09	expressed with a unit of
Oct.	30.4	18.9	24.6	63.3	0.5	7.0	2.63	knots. An equivalent rate
Nov.	25.6	14.3	20.0	67.3	1.0	9.0	2.01	of 0.515 m/sec to one
Dec.	20.4	8.9	14.6	70.0	3.0	14.0	1.55	knot is used.
Mean or Total	28.6	15.7	22.2	60.5	9.2		2.50	

Source: MOI, Fayoum

Table B1-3 Climatological Condition at Fayoum (Year 1931-1960)

Location: Lat. 29°18'N Langit. 30°51'E

Month	Temperature Max. (°C)	Temperature Mini. (°C)	Temperature Mean(1) (°C)	Relative Humidity(2) (%)	Rainfall Mean (mm)	Rainfall Max.(3) (mm)	Mean(4) Wind Speed (m/sec)	Remark
Jan.	20.3	6.1	13.2	61.0	0.9	5.0	1.18	(1) Mean temp. =(Max.+ Min.)/2
Feb.	22.0	7.3	14.6	54.7	1.9	6.5	1.64	
Mar.	25.1	9.9	17.5	46.3	1.6	11.8	2.11	(2) Relative Humidity is the
Apr.	30.1	12.9	21.5	46.3	0.7	13.0	2.42	mean value of data observed
May	34.0	17.2	25.6	35.0	1.2	20.8	2.78	at 6:00, 12:00 and 18:00
Jun.	35.8	19.7	27.8	37.3	0.0	0.0	2.99	(3) The Max. Rainfall had been
Jul.	36.7	21.2	29.0	42.3	0.0	0.0	2.58	occurred in the past years.
Aug.	36.5	21.5	29.0	46.0	0.0	0.0	2.42	(4) The original data are
Sep.	33.7	19.6	26.6	52.7	0.0	0.0	2.58	expressed with a unit of
Oct.	31.2	17.1	24.2	53.0	1.0	9.0	2.78	knots. An equivalent rate
Nov.	26.5	13.1	19.8	62.0	0.7	3.3	1.49	of 0.515 m/sec to one
Dec.	21.8	8.5	15.2	62.7	5.7	44.0	1.03	knot is used.
Mean or Total	29.5	14.5	22.0	49.9	13.7		2.17	

Source: MOI, Fayoum

Table B1-4 Daily Max., Min. and Mean Temperature, 1984
(Azbz Station)

(Unit: °C)

MARCH OF 1984

DAY	MAX.	MIN.	MEAN
16	26.0	11.2	18.6
17	25.0	9.5	17.2
18	23.5	8.0	15.7
19	20.5	7.2	13.8
20	25.0	11.5	18.2
21	28.5	12.5	20.5
22	25.0	15.0	20.0
23	27.0	17.0	22.0
24	21.0	11.2	16.1
25	22.0	8.0	15.0
26	20.0	6.5	13.2
27	19.8	8.5	14.1
28	21.5	9.0	15.2
29	23.0	10.5	16.7
30	23.0	9.0	16.0
31	27.0	12.0	19.5
MEAN	23.6	10.4	17.0

Note; A value of zero(0) means no available data.

APRIL OF 1984

DAY	MAX.	MIN.	MEAN
1	28.0	12.0	20.0
2	25.0	10.0	17.5
3	25.5	9.5	17.5
4	30.0	11.3	20.6
5	33.0	13.5	23.2
6	33.0	13.5	23.2
7	29.8	10.2	20.0
8	24.0	12.0	18.0
9	24.2	8.8	16.5
10	25.0	8.8	16.9
11	24.2	12.0	18.1
12	30.0	14.8	22.4
13	36.2	15.0	25.6
14	32.5	16.0	24.2
15	25.0	12.0	18.5
16	25.5	10.0	17.7
17	28.2	17.4	22.8
18	30.5	14.5	22.5
19	23.0	15.2	19.1
20	28.5	12.5	20.5
21	24.5	11.8	18.1
22	22.5	8.0	15.2
23	23.5	11.0	17.2
24	23.0	9.5	16.2
25	24.0	9.2	16.6
26	27.0	13.5	20.2
27	32.5	13.0	22.7
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
MEAN	27.3	12.0	19.6

MAY OF 1984

DAY	MAX.	MIN.	MEAN
2	38.8	21.0	29.9
3	28.8	16.0	22.4
4	29.8	16.2	23.0
5	28.6	14.5	21.5
6	33.0	16.0	24.5
7	30.2	14.0	22.1
8	27.5	13.0	20.2
9	28.8	14.6	21.7
10	33.4	18.2	25.8
11	36.0	21.0	28.5
12	40.5	22.5	31.5
13	31.5	14.5	23.0
14	29.8	15.0	22.4
15	30.0	15.0	22.5
16	33.2	18.9	26.0
17	27.0	21.0	24.0
18	40.2	22.0	31.1
19	36.2	19.0	27.6
20	34.0	16.0	25.0
21	34.8	22.0	28.4
22	40.0	21.0	30.5
23	36.0	17.8	26.9
24	35.5	21.5	28.5
25	40.5	23.5	32.0
26	36.0	19.0	27.5
27	31.8	16.5	24.1
28	30.5	17.4	23.9
29	35.8	21.0	28.4
30	40.5	19.0	29.7
31	33.2	18.0	25.6
MEAN	33.7	18.1	25.9

JUNE OF 1984

DAY	MAX.	MIN.	MEAN
1	36.0	19.5	27.7
2	30.8	16.0	23.4
3	30.2	16.5	23.3
4	32.2	18.0	25.1
5	31.8	18.8	25.3
6	33.2	18.5	25.8
7	34.0	19.0	26.5
8	36.0	20.5	28.2
9	37.0	19.0	28.0
10	35.8	20.8	28.3
11	34.5	18.4	26.4
12	33.1	18.0	25.5
13	32.5	18.0	25.2
14	31.0	18.4	24.7
15	31.5	18.0	24.7
16	31.5	16.0	23.7
17	31.5	17.0	24.2
18	33.5	20.0	26.7
19	34.0	17.0	25.5
20	30.8	17.0	23.9
21	31.6	18.2	24.9
22	31.0	20.0	25.5
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	33.4	20.0	26.7
27	34.0	20.5	27.2
28	33.8	20.2	27.0
29	33.5	18.0	25.7
30	33.6	19.8	26.7
MEAN	33.0	18.5	25.7

Table B1-4 Daily Max., Min. and Mean Temperature, 1984 (Cont'd)
(Azba Station)

(Unit; %)

JULY OF 1984

DAY	MAX.	MIN.	MEAN
1	37.0	21.0	29.0
2	37.1	19.0	28.0
3	37.4	22.6	30.0
4	36.5	21.0	28.7
5	38.0	22.4	30.2
6	35.5	20.0	27.7
7	33.2	19.5	26.3
8	32.5	17.8	25.1
9	32.0	19.0	25.5
10	33.0	17.0	25.0
11	34.0	20.5	27.2
12	36.0	21.0	28.5
13	36.0	22.0	29.0
14	37.0	23.0	30.0
15	36.0	23.0	29.5
16	37.5	24.0	30.7
17	35.0	25.0	30.0
18	36.5	21.5	29.0
19	37.8	20.0	28.9
20	33.0	21.0	27.0
21	33.0	18.0	25.5
22	34.2	19.0	26.6
23	34.0	21.0	27.5
24	35.5	21.5	28.5
25	36.8	21.5	29.1
26	36.5	19.5	28.0
27	36.0	21.0	28.5
28	39.0	22.0	30.5
29	35.0	20.5	27.7
30	28.0	20.5	24.2
31	28.0	18.0	23.0
MEAN	35.0	20.7	27.9

AUGUST OF 1984

DAY	MAX.	MIN.	MEAN
1	30.0	18.0	24.0
2	30.5	18.0	24.2
3	31.2	17.8	24.5
4	32.5	17.5	25.0
5	33.5	17.5	25.5
6	32.5	18.0	25.2
7	33.5	18.0	25.7
8	32.0	19.0	25.5
9	31.2	18.5	24.8
10	32.5	18.5	25.5
11	34.5	19.0	26.7
12	34.0	18.2	26.1
13	34.5	19.0	26.7
14	37.6	19.0	28.3
15	40.0	21.5	30.7
16	38.5	22.5	30.5
17	33.0	21.0	27.0
18	32.0	20.0	26.0
19	33.0	20.0	26.5
20	33.5	20.0	26.7
21	33.0	18.0	25.5
22	33.0	19.5	26.2
23	34.0	18.5	26.2
24	32.2	18.0	25.1
25	34.0	19.5	26.7
26	37.5	19.5	28.5
27	34.0	22.5	28.2
28	31.8	19.8	25.8
29	32.0	19.5	25.7
30	33.5	20.5	27.0
31	36.0	22.0	29.0
MEAN	33.5	19.3	26.4

SEPTEMBER OF 1984

DAY	MAX.	MIN.	MEAN
1	37.0	21.0	29.0
2	32.0	20.0	26.0
3	31.5	18.5	25.0
4	32.0	18.2	25.1
5	32.5	18.5	25.5
6	33.0	20.0	26.5
7	33.0	21.0	27.0
8	33.0	17.5	25.2
9	35.2	19.5	27.3
10	35.0	18.0	26.5
11	37.5	20.5	29.0
12	38.5	20.0	29.2
13	33.0	21.0	27.0
14	31.5	19.0	25.2
15	33.0	18.0	25.5
16	33.0	18.5	25.7
17	31.5	18.0	24.7
18	31.8	17.0	24.4
19	35.0	18.5	26.7
20	37.0	21.0	29.0
21	37.5	19.0	28.2
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	0.0	0.0	0.0
27	0.0	0.0	0.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
MEAN	33.9	19.1	26.5

Note:
A value of Zero (0) means no available data.

Table B1-5 Daily Max., Min. and Mean Humidity, 1984

(Azba Station)

(Unit: %)

MARCH OF 1984

*** HUMIDITY ***

DAY	MAX.	MIN.	MEAN
16	74.0	34.0	54.0
17	82.0	21.0	51.5
18	77.0	10.0	43.5
19	75.0	19.0	47.0
20	60.0	5.0	32.5
21	60.0	0.0	30.0
22	71.0	18.0	44.5
23	77.0	18.0	47.5
24	77.0	41.0	59.0
25	75.0	22.0	48.5
26	75.0	18.0	46.5
27	72.0	21.0	46.5
28	75.0	22.0	48.5
29	78.0	18.0	48.0
30	81.0	13.0	47.0
31	62.0	0.0	31.0
MEAN	73.1	17.5	45.3

Note: A value of zero(0) means no available data.

APRIL OF 1984

*** HUMIDITY ***

DAY	MAX.	MIN.	MEAN
1	73.0	8.0	40.5
2	75.0	8.0	41.5
3	80.0	9.0	44.5
4	62.0	0.0	31.0
5	74.0	7.0	40.5
6	45.0	0.0	22.5
7	74.0	8.0	41.0
8	76.5	8.0	42.2
9	62.0	10.0	36.0
10	78.0	7.0	42.5
11	66.0	12.0	39.0
12	44.0	8.0	26.0
13	74.0	2.0	38.0
14	71.0	6.0	38.5
15	76.0	18.0	47.0
16	70.0	14.0	42.0
17	38.0	10.0	24.0
18	66.0	17.0	41.5
19	32.5	21.0	26.7
20	76.0	12.0	44.0
21	70.0	14.0	42.0
22	67.0	13.0	40.0
23	68.0	15.0	41.5
24	64.5	18.0	41.2
25	68.0	10.0	39.0
26	43.0	4.0	23.5
27	74.0	4.0	39.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
MEAN	65.4	9.7	37.6

MAY OF 1984

*** HUMIDITY ***

DAY	MAX.	MIN.	MEAN
2	59.0	0.0	29.5
3	72.0	24.0	48.0
4	76.0	16.5	46.2
5	79.0	13.0	46.0
6	69.0	0.0	34.5
7	75.0	10.0	42.5
8	78.0	15.0	46.5
9	60.0	3.0	31.5
10	44.5	0.0	22.2
11	28.0	0.0	14.0
12	56.0	0.0	28.0
13	74.0	20.0	47.0
14	77.0	12.0	44.5
15	76.0	8.0	42.0
16	57.0	0.0	28.5
17	48.0	0.0	24.0
18	46.0	0.0	23.0
19	62.0	8.0	35.0
20	59.0	4.0	31.5
21	36.0	6.0	21.0
22	50.0	6.0	28.0
23	75.0	3.5	39.2
24	32.0	3.0	17.5
25	53.5	0.0	26.7
26	73.0	16.0	44.5
27	64.0	8.0	36.0
28	58.0	8.0	33.0
29	38.0	1.0	19.5
30	73.0	4.0	38.5
31	49.0	10.0	29.5
MEAN	59.9	6.6	33.2

JUNE OF 1984

*** HUMIDITY ***

DAY	MAX.	MIN.	MEAN
1	48.0	4.0	26.0
2	79.0	23.0	51.0
3	76.0	19.0	47.5
4	76.0	15.0	45.5
5	77.0	19.0	48.0
6	70.0	10.0	40.0
7	72.0	10.0	41.0
8	56.0	2.0	29.0
9	78.0	5.0	41.5
10	60.0	2.0	31.0
11	77.0	9.0	43.0
12	75.0	5.0	40.0
13	72.0	8.0	40.0
14	75.0	16.0	45.5
15	74.0	16.0	45.0
16	67.0	8.0	37.5
17	75.0	12.0	43.5
18	74.0	10.0	42.0
19	69.5	6.0	37.7
20	73.0	20.0	46.5
21	75.0	11.0	43.0
22	78.0	11.0	44.5
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	72.0	14.0	43.0
27	73.0	8.0	40.5
28	70.0	10.0	40.0
29	73.0	8.0	40.5
30	73.0	18.0	45.5
MEAN	71.7	11.0	41.4

Table B1-5 Daily Max., Min. and Mean Humidity, 1984 (Cont'd)
(Azba Station)

(Uint; %)

JULY OF 1984

*** HUMIDITY ***

DAY	MAX.	MIN.	MEAN
1	63.0	6.0	34.5
2	76.0	3.0	39.5
3	66.0	4.0	35.0
4	72.0	1.0	36.5
5	60.0	2.0	31.0
6	64.0	6.0	35.0
7	70.0	10.0	40.0
8	68.0	16.0	42.0
9	69.0	16.0	42.5
10	73.5	12.0	42.7
11	76.2	12.2	44.2
12	77.0	12.0	44.5
13	74.0	9.0	41.5
14	66.0	13.0	39.5
15	74.5	17.0	45.7
16	70.0	10.0	40.0
17	69.0	6.0	37.5
18	66.0	4.0	35.0
19	68.0	2.0	35.0
20	78.0	10.0	44.0
21	76.0	10.0	43.0
22	76.0	6.0	41.0
23	74.0	9.0	41.5
24	74.0	19.0	46.5
25	73.0	6.0	39.5
26	75.0	12.0	43.5
27	76.0	12.0	44.0
28	74.0	9.5	41.7
29	81.0	14.0	47.5
30	66.0	18.0	42.0
31	68.0	26.0	47.0
MEAN	71.3	10.0	40.7

AUGUST OF 1984

*** HUMIDITY ***

DAY	MAX.	MIN.	MEAN
1	73.0	20.5	46.7
2	74.0	12.0	43.0
3	68.0	6.0	37.0
4	73.0	4.0	38.5
5	76.0	16.0	46.0
6	77.0	10.0	43.5
7	74.0	8.0	41.0
8	75.0	3.0	39.0
9	77.0	5.0	41.0
10	74.0	8.0	41.0
11	74.0	4.0	39.0
12	78.0	4.0	41.0
13	72.0	4.0	38.0
14	66.0	6.0	36.0
15	66.0	3.0	34.5
16	56.0	11.0	33.5
17	74.0	12.0	43.0
18	66.0	18.0	42.0
19	73.0	21.0	47.0
20	76.0	8.0	42.0
21	76.0	12.0	44.0
22	76.0	12.0	44.0
23	71.0	14.0	42.5
24	73.0	18.0	45.5
25	75.0	18.0	46.5
26	81.0	0.0	40.5
27	74.0	17.0	45.5
28	78.0	19.0	48.5
29	84.0	25.0	54.5
30	76.0	13.0	44.5
31	86.0	11.0	48.5
MEAN	73.9	11.0	42.4

SEPTEMBER OF 1984

*** HUMIDITY ***

DAY	MAX.	MIN.	MEAN
1	78.0	16.0	47.0
2	81.0	20.0	50.5
3	81.0	17.0	49.0
4	80.0	16.0	48.0
5	84.0	12.0	48.0
6	82.0	20.0	51.0
7	81.0	13.0	47.0
8	84.0	6.0	45.0
9	83.0	3.0	43.0
10	84.0	6.0	45.0
11	69.0	10.0	39.5
12	62.0	9.0	35.5
13	83.0	17.0	50.0
14	79.0	16.0	47.5
15	81.0	11.0	46.0
16	76.0	10.0	43.0
17	82.0	16.0	49.0
18	82.0	14.0	48.0
19	81.0	10.0	45.5
20	66.0	6.0	36.0
21	64.0	2.0	33.0
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	0.0	0.0	0.0
27	0.0	0.0	0.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
MEAN	78.2	11.9	45.0

Note:
A value of zero(0) means no available data.

Table B1-6 Daily Wind Speed and Direction at Azba Station

MONTH/YEAR..MARCH/1984

DATE	WIND SPEED IN M/SEC DAY	NIGT	AVE.	WIND DIRC.
21	2.9	2.6	2.8	NE
22	2.2	1.1	1.6	SW
23	2.3	2.8	2.5	NE
24	1.2	3.1	2.1	SW
25	2.9	1.5	2.2	
26	2.7	1.8	2.2	
27	3.1	2.6	2.8	
28	5.0	3.3	4.1	
29	4.7	2.8	3.8	
30	3.9	3.0	3.4	
31	3.2	2.2	2.7	
MEAN	3.1	2.4	2.8	NE

MONTH/YEAR..APRIL/1984

DATE	WIND SPEED IN M/SEC DAY	NIGT	AVE.	WIND DIRC
1	3.3	5.1	4.2	
2	3.8	3.5	3.7	
3	3.8	2.4	3.1	
4	2.7	2.8	2.7	
5	1.7	2.3	2.0	
6	1.8	1.6	1.7	
7	3.1	1.2	2.1	
8	3.6	1.9	2.7	
9	3.2	1.3	2.2	
10	3.0	2.1	2.5	
11	2.1	2.2	2.2	
12	1.9	1.3	1.6	
13	2.7	4.2	3.4	
14	2.9	3.1	3.0	
15	3.4	1.5	2.5	
16	2.7	2.1	2.4	
17	1.5	0.9	1.2	
18	3.0	3.8	3.4	
19	4.3	2.4	3.4	
20	3.0	2.2	2.6	
21	0.0	0.0	0.0	
22	0.0	0.0	0.0	
23	0.0	0.0	0.0	
24	0.0	0.0	0.0	
25	0.0	0.0	0.0	
26	0.0	0.0	0.0	
27	0.0	0.0	0.0	
28	0.0	0.0	0.0	
29	0.0	0.0	0.0	
30	0.0	0.0	0.0	
MEAN	2.9	2.4	2.6	

MONTH/YEAR..MAY/1984

DATE	WIND SPEED IN M/SEC DAY	NIGT	AVE.	WIND DIRC.
1	4.2	4.2	4.2	SW
2	3.2	2.5	2.9	
3	3.8	2.4	3.1	
4	2.7	2.6	2.7	
5	2.9	3.3	3.1	
6	2.2	1.7	1.9	
7	2.4	2.1	2.3	
8	3.2	2.7	2.9	
9	2.9	3.3	3.1	
10	3.1	3.9	3.5	
11	5.1	4.0	4.6	
12	1.7	1.6	1.7	
13	5.0	2.9	3.9	N
14	4.9	5.4	5.1	N
15	5.4	4.3	4.8	NE
16	6.4	4.7	5.5	NE
17	5.4	5.6	5.5	NE
18	0.0	0.0	0.0	NE
19	0.0	0.0	0.0	NE
20	0.0	0.0	0.0	NE
21	0.0	0.0	0.0	NE
22	0.0	0.0	0.0	
23	0.0	0.0	0.0	
24	0.0	0.0	0.0	
25	0.0	0.0	0.0	
26	0.0	0.0	0.0	
27	0.0	0.0	0.0	
28	0.0	0.0	0.0	
29	0.0	0.0	0.0	
30	0.0	0.0	0.0	
31	0.0	0.0	0.0	
MEAN	3.8	3.4	3.6	NE

MONTH/YEAR..JUNE/1984

DATE	WIND SPEED IN M/SEC DAY	NIGT	AVE.	WIND DIRC.
1	0.0	0.0	0.0	
2	0.0	0.0	0.0	
3	0.0	0.0	0.0	
4	0.0	0.0	0.0	
5	0.0	0.0	0.0	
6	0.0	0.0	0.0	
7	0.0	0.0	0.0	
8	0.0	0.0	0.0	
9	0.0	0.0	0.0	
10	0.0	0.0	0.0	
11	0.0	0.0	0.0	
12	0.0	0.0	0.0	
13	0.0	0.0	0.0	
14	0.0	0.0	0.0	
15	0.0	0.0	0.0	
16	0.0	0.0	0.0	
17	0.0	0.0	0.0	
18	0.0	0.0	0.0	
19	0.0	0.0	0.0	
20	3.3	1.7	2.5	NE
21	4.3	2.6	3.4	E
22	3.7	3.4	3.5	E
23	2.6	3.3	2.9	SE
24	2.3	3.6	2.9	SE
25	1.2	3.3	2.2	N
26	2.7	4.5	3.6	NE
27	2.6	2.6	2.6	N
28	2.5	2.5	2.5	N
29	2.7	3.8	3.2	N
30	4.1	2.6	3.3	N
MEAN	2.9	3.0	2.9	N

Note: The figure of zero (0) means no available data.

Wind direction shows most frequent direction a day.

The observation times are 9, 12, 15, 18, 21, 24, 3, 6 o'clock. Day time is from 9 to 18 and night time from 21 to 6 o'clock.

Table B1-6 Daily Wind Speed and Direction at Azba Station (Cont'd)

MONTH/YEAR..JULY/1984

DATE	WIND SPEED IN M/SEC DAY	NIGT	AVE.	WIND DIRC.
1	3.3	1.8	2.5	N
2	2.3	3.2	2.8	NE
3	3.6	3.0	3.3	NE
4	3.0	2.5	2.7	N
5	3.5	2.6	3.0	NE
6	4.2	2.4	3.3	N
7	4.2	2.1	3.1	N
8	5.0	3.5	4.2	N
9	6.0	3.0	4.5	N
10	4.5	3.2	3.8	N
11	4.0	2.5	3.3	N
12	2.1	2.7	2.4	NW
13	1.7	2.3	2.0	NW
14	1.7	2.6	2.1	NW
15	1.8	3.0	2.4	NW
16	2.2	2.4	2.3	N
17	1.4	1.5	1.4	NW
18	0.0	0.0	0.0	
19	0.0	0.0	0.0	
20	2.2	2.0	2.1	N
21	2.2	2.2	2.2	N
22	2.2	2.6	2.4	N
23	2.0	3.3	2.6	N
24	3.2	3.7	3.4	N
25	2.6	1.5	2.0	N
26	1.9	2.5	2.2	N
27	3.1	3.2	3.1	N
28	2.2	2.0	2.1	N
29	1.6	2.6	2.1	NW
30	2.4	2.4	2.4	NW
31	3.6	5.0	4.3	NW
MEAN	2.9	2.6	2.8	N

MONTH/YEAR..AUGUST/1984

DATE	WIND SPEED IN M/SEC DAY	NIGT	AVE.	WIND DIRC.
1	5.8	6.7	6.2	W
2	5.3	6.0	5.6	W
3	4.3	2.7	3.5	N
4	2.7	1.5	2.1	N
5	2.0	1.3	1.6	NW
6	1.5	2.2	1.8	NW
7	2.1	3.7	2.9	N
8	2.8	3.7	3.2	N
9	3.5	4.2	3.8	N
10	3.8	2.3	3.0	NE
11	2.5	2.1	2.3	N
12	2.7	1.8	2.2	N
13	3.1	1.5	2.3	NW
14	1.5	1.8	1.6	NW
15	1.8	2.1	1.9	NW
16	1.7	3.8	2.7	N
17	3.0	3.3	3.1	N
18	3.8	2.6	3.2	N
19	4.0	3.6	3.8	N
20	3.8	2.9	3.3	N
21	3.2	3.0	3.1	NE
22	3.7	2.4	3.0	N
23	2.9	1.8	2.3	N
24	3.2	2.4	2.8	N
25	3.3	2.7	3.0	N
26	1.5	1.5	1.5	N
27	1.7	2.0	1.8	NW
28	3.4	2.7	3.0	N
29	3.6	2.8	3.2	NE
30	3.6	3.1	3.4	0
31	3.7	3.4	3.5	0
MEAN	3.0	2.8	2.9	N

MONTH/YEAR..SEPT./1984

DATE	WIND SPEED IN M/SEC DAY	NIGT	AVE.	WIND DIRC.
1	1.6	2.9	2.2	0
2	2.8	3.4	3.1	0
3	2.6	2.7	2.7	N
4	2.8	2.6	2.7	N
5	3.9	2.9	3.4	NE
6	4.8	3.5	4.1	NE
7	3.6	2.1	2.9	NE
8	2.4	1.1	1.8	N
9	0.0	0.0	0.0	
10	0.0	0.0	0.0	
11	0.0	0.0	0.0	
12	0.0	0.0	0.0	
13	3.0	1.8	2.4	N
14	2.0	1.9	1.9	N
15	1.5	2.3	1.9	N
16	2.2	2.7	2.4	NE
17	3.1	2.8	3.0	NE
18	3.7	2.6	3.2	NE
19	4.0	2.9	3.4	NE
20	3.6	2.7	3.1	NE
21	3.6	3.8	3.7	NE
22	3.8	3.8	3.8	NE
23	3.8	3.9	3.9	NE
MEAN	3.1	2.8	2.9	NE

Note: The figure of zero (0) means no available data.

Wind direction shows most frequent direction a day.

The observation times are 9, 12, 15, 18, 21, 24, 3 and 6 o'clock. Day time is from 9 to 18, night time from 21 to 6 o'clock.

During the field survey period the observation data up to 23rd of September, 1984 are collected.

Table B1-7 Daily Evaporation Rate at Azba Station

EVAPORATION IN MM/DAY

DAY	MAR	APR	MAY
	M O N T H		
1	0	7	11
2	0	8	9
3	0	7	8
4	0	7	9
5	0	6	7
6	0	7	10
7	0	7	9
8	0	7	8
9	0	6	9
10	0	8	11
11	0	7	11
12	0	5	7
13	0	9	9
14	0	7	10
15	0	7	10
16	0	7	13
17	6	5	14
18	6	10	14
19	6	7	14
20	5	9	9
21	7	10	12
22	2	9	10
23	1	6	10
24	0	7	11
25	5	8	11
26	4	7	13
27	5	8	13
28	7	8	10
29	7	10	12
30	7	12	14
31	7	0	10
SUM	77	219	329
AVE	5	7	10

EVAPORATION IN MM/DAY

DAY	JUN	JUL	AUG	SEP
	M O N T H			
1	10	0	5	6
2	9	0	8	10
3	14	9	9	0
4	11	0	10	6
5	0	11	8	6
6	15	12	8	10
7	15	9	8	11
8	13	9	9	9
9	15	10	11	7
10	0	0	9	7
11	0	0	9	11
12	0	11	0	0
13	0	13	0	8
14	0	13	0	8
15	0	8	0	9
16	0	0	0	8
17	15	12	0	9
18	13	6	7	8
19	15	11	9	10
20	13	9	8	11
21	10	0	9	13
22	15	0	7	10
23	10	0	8	0
24	15	0	8	0
25	0	0	10	0
26	9	0	0	0
27	9	0	12	0
28	0	0	9	0
29	0	0	6	0
30	0	0	13	0
31	0	0	9	0
SUM	226	143	191	177
AVE	12	10	8	8

Note: A figure of zero (0) is no available data because of no good condition of the instrument.
A class "A" Pan is attached with the instrument.
A unit of above figures is mm/day.

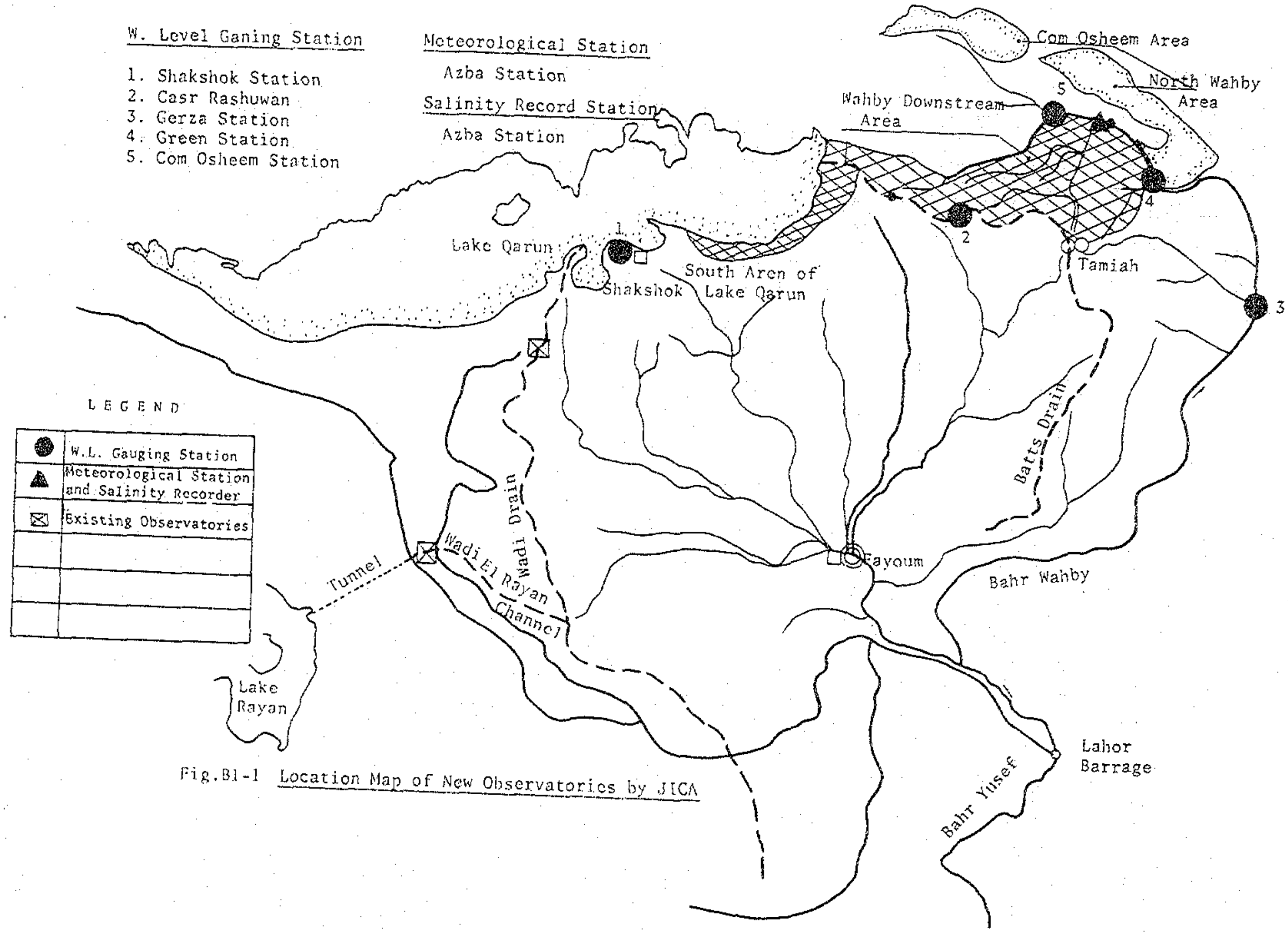


Fig.B1-1 Location Map of New Observatories by JICA

Fig. B1-2 Automatic Recording at Azba Station
(on 20th Sept. 1984)

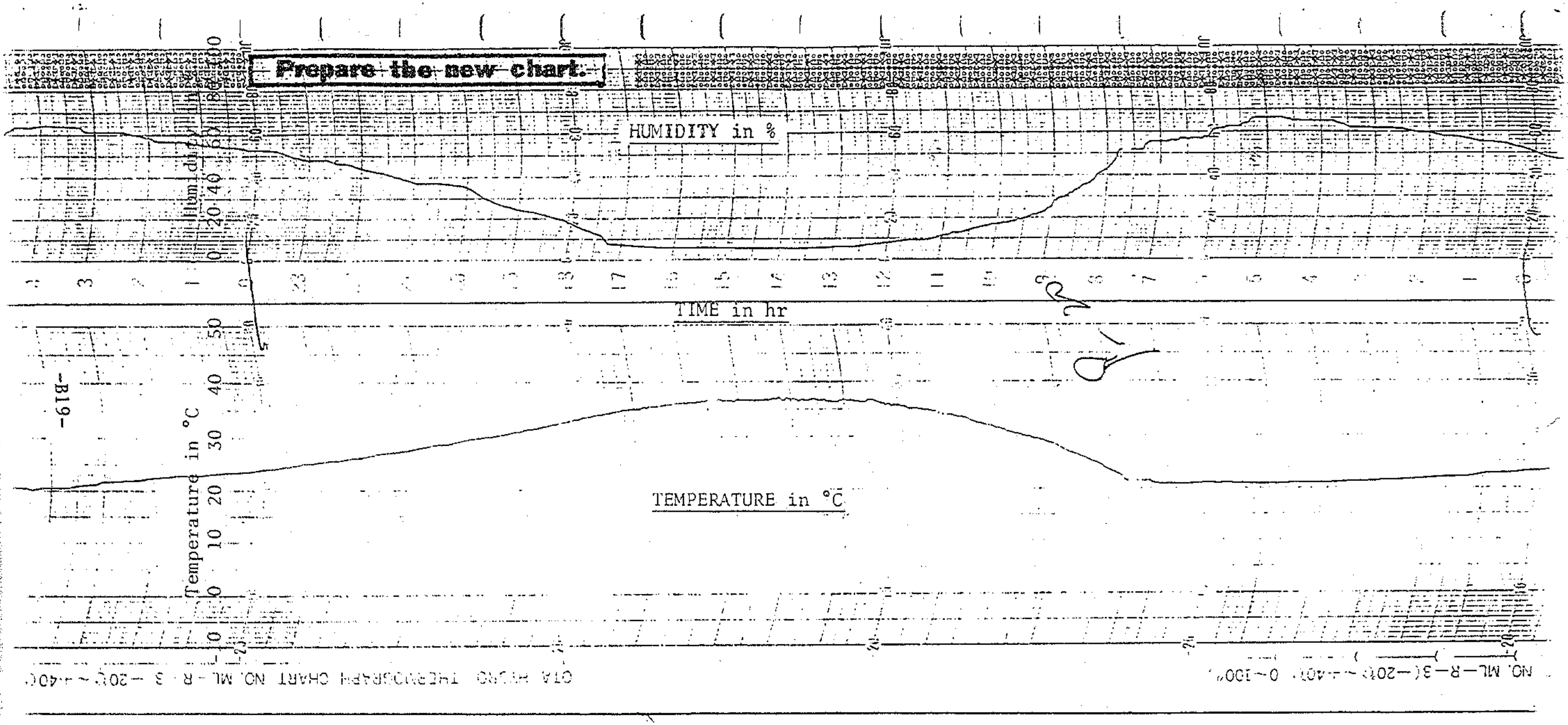
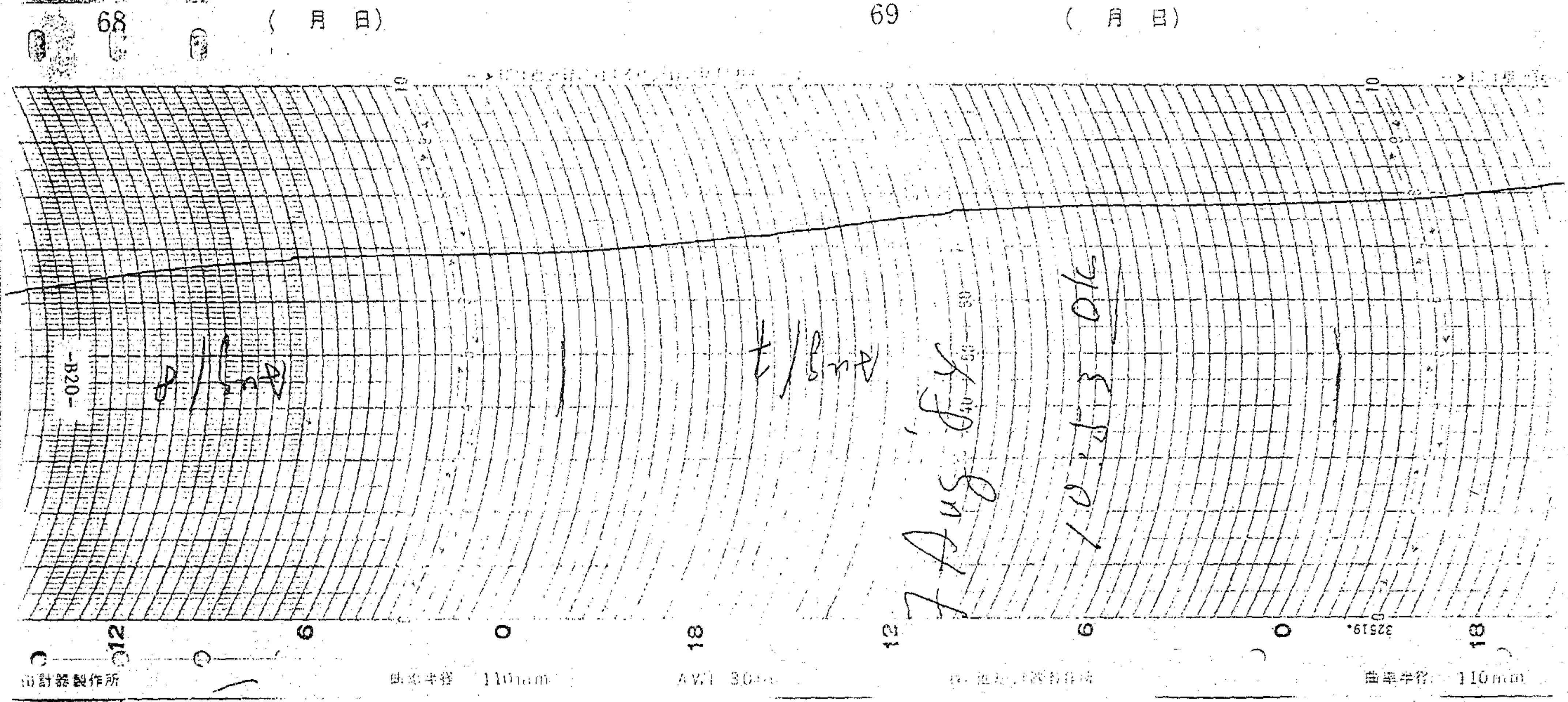


Fig. B1-3 Daily Evaporation Record at Azba Station on 7th of August, 1984



Note: A class "A" Pan is attached with the autimatic recorder.

B-2. Hydrological Analysis

B-2.1. Existing Gauging Station on Bahr Wahby

There ar so many stuff gauges on the structures which were constructed on Bahr Wahby. However, almost all stuff gauges are not working no more. Only one staff gauge is working on the Seka Hadid weir which is located at about 17 km downstream from the intake point of Bahr Wahby.

Recently, the Dutch government dispatched a study team for water and salt balance of Lake Qarun. The study had been started on 1983 and will be ended on 1985. The team has distributed six automatic water level gauges in the Fayoum depression. In the near future, the team intends to increase about 16 to 18 gauging stations in the depression area. One station of which has been established on the intake point of Bahr Wahby. (refer to Fig. B2-1)

The staff gauges attached on the structures on Bahr Wahby were not worked and no data are available at present. At the many staff gauges near and on the weir controlling water level of Bahr Wahby, the calibration of discharge should be needed.

B-2.2. New Water Level Gauging Stations

The JICA Team has newly installed five water level gauges in and around the Project Area. One of which is for automatically recording of water level of Lake Qarun at Shakshok. Another one of which is for grasping an amount of discharge in Batts drain at Casr Rashuwan. Other three stations are installed at KM 34.66, 49.71 and 55.64 on the Bahr Wahby. The Figure B1-1 shows the location of stations.

(1) Shakshok Station

Utilizing an existing observation well for water level of Lake Qarun, the automatic water level recorder has been installed on the well. The relation between the actual water level based on the mean sea level (MSL) and observation is as follows:

Actual Water Level (m)	Observation on the Paper (m)	Existing Staff Gauge (cm)
-42.50	5.82	-0.50
-43.00	5.32	0.00
-43.50	4.82	0.50
-44.00	4.32	1.00
-44.50	3.82	1.50
-45.00	3.32	2.00

cf. -43.45 m = 4.87 m = 0.45 cm
-43.60 m = 4.72 m = 0.60 m

The outline of the instrument is as follows;

* Observation period - Three month without changing recording paper

* Observation depth - up to ten meters

* Recording system - two recording pens system, one pen records for a meter unit and other pen for centimeter unit

Table B1-1 presents more detail informations regarding to the specification of the instrument.

(2) Casr Rashuwan Station on Batts Drain

This station is located at the Casr Rashuwan weir which exists at 250 m downstream from the bridge beside the town of Casr Rashuwan, which is stationing at KM 14.65 of Batts Drain.

The relation between the gauge reading and elevation of water level based on MSL is that 5.55 m of reading of the automatic gauge is equal to 35.9 m below MSL. The measuring instruments is fixed on the upstream weir body. The width of the weir is seven meters. Table B1-1 presents more detail information about the specification of the instrument.

(3) Gerza Station on Bahr Wahby

The gauging station is installed at KM 34.66 and is attached the abutment of the bridge over-passing Bahr Wahby. This bridge exists at just downstream of the branch-off point of Bahr Serb. The relation between the gauge reading and water level based on MSL is that 4.99 m on the recording paper is equal to 14.00 m above MSL. Table B1-1 shows the specification of the instruments.

(4) Green Station on Bahr Wahby

This automatic recorder is installed on the intake structure of Bahr Green, which is KM 49.71 of Bahr Wahby. The indicate of 5.54 m on the gauge scale is an elevation of 13.9 m above MSL. Table B1-1 shows the detail specification of this instrument.

(5) Com Osheem Station

The station is constructed on the intake facility of Com Osheem canal which is one of major branch canal, which located at KM 55.64 on Bahr Wahby. A water level of 10.08 m above MSL is scaled at 5.54 m on the recording paper in the instrument. Table B1-1 describes for the further details about the instrument.

B-2.3. Salinity Recording Station on Bahr Wahby

The JICA Team also established the salinity recorder on Bahr Wahby, which is located at the intake structure of Bahr Fanaus. This station will play a very important role to keep suitable quality of mixed water for irrigation. (refer to Fig. B1-1)

The automatic salinity censor is always submerged in water of Bahr Wahby. The recorder is settled in the neighboring MOI labor house. The recorder has a mode select switch which can choose recording modes among 12 hours interval automatic recording, every hour interval automatic recording and manual operation. The censor can catch salt concentration from 200 ppm to 2,000 ppm with accuracy of three percent. For further detail informations about the specification of the salinity recorder is described at Table B1-1.

B-2.4. Water Distribution in Fayoum

Water for Fayoum depression is traveling about 270 km after intaking water at the Asuit barrage on Nile river and is controlled and distributed at the Lahorn barrage under MOI, Beni Suef. The annual discharge to Fayoum Governorate is about 2,300 MCM in average. (refer to Table B2-1) The major carries of Bahr Yousef and Bahr Hassan Wasef convey water to the Fayoum area. There are 324 routes of canals to a field with a gravity irrigation system, since a land slope of about 1:300 in average is advantageously for the gravity system. A traditional lift irrigation system with "Sakia" in Egypt is rarely used in the Fayoum area. (refer to Fig. B2-2)

Bahr Wahby with the total irrigated area of about 73,000 feddan is one of the main canal in the area, which is branched off from Bahr Yousef. Since an elevation of an area on the right bank of Bahr Wahby is higher than the elevation of controlled water level of Bahr Wahby, the area on the right bank needs a lift irrigation system. However, an area of the left bank is extended at lower than the water level of the canal. The Project area is located on the both side of the downstream of this canal. (refer to Fig. B2-3)

On the other hand, the drainage system in Fayoum is an interesting closed drainage system, that is, all drainage canals are pouring to Lake Qarun which has a no outlet to drain water in old time. In 1974, Wadi El Rayan channel was constructed to share drainage discharge from the catchment area of the Wadi drain. The amount of discharge of two third in the Wadi drain is diverted to Lake Rayan through the Wadi El Rayan channel. (refer to Table B2-2)

The above both drain commands the area of about 90 percent of the Fayoum area, including the drainage area of 58,000 feddan under Wadi El Rayan channel. (refer to Table B2-3) The other drainage canals of 12 routes have a small drainage are from 280 to 8,600 feddan. (refer to Fig. B2-4)

The outlet of Lake Qarun is only evaporation from the lake surface. The annual amount of evaporation is 316 MCM.
(refer to Table B2-4)

B-2.5. Discharge Measurement

(1) Measuring Point

During the field survey, the discharge measurement works with mesh survey points of 50 cm interval in horizontal and 25 cm interval in vertical have been carried out at the four points of Casr Rashuwan, Gerza, Green and Com Osheem points at where the water level gauging stations were constructed.

(2) Measuring Equipments and Operation

An electric water current meter of Nakaasa Price type, Model No. J-011 with instruments No. 8527 has been employed to measure a velocity of water in a canal.

Measuring operation on the above survey points has been carried out on August and September, 1984. Twice measurings at a measuring operation have been done to check measuring data and to protect miss operations.

(3) Longitudinal Discharge Distribution

Based on the above actual measured discharge and the service area of Bahr Wahby, the amount of longitudinal discharge in the canal has been calculated. The amount of intake discharge at the Seka Hadid weir with an area served of 60,000 feddan is calculated at 14.2 cu.m/sec/feddan which is equivalented from the overflow water depth on the crest of the weir to discharge by using the rating curve presented by MOI, Fayoum. (refer to Tables B2-5 and B2-6)

The other three discharge of 7.6, 3.6 and 2.0 cu.m/sec were measured at the Gerza on Km 34.66, at the Green on KM 49.71 and at the Com Osheem on KM 55.64, on August, 1984, respectively.

Based on the acreage of the area served and discharge, the water duties at Gerza, Green and Com Osheem were calculated at 20.7, 13.9 and 15.9 cu.m/day/feddan, respectively. According to the results of the water duty, the water duty at Com Osheem is rather that that of the original rate of 17.1 cu.m/day/feddan and also lower than that of 25 cu.m/day/feddan in Fayoum Governorate. (refer to Fig. B2-5 and Table B2-1)

On the other hand, the three automatic water level gauge recorded at water level. Fig. B2-6 shows the typical fluctuation of water level during the night time. During this period, all station indicated to down water level. The farmers made some illegal hole on the vents to get more irrigation water for farming because small water duty of 13.9 cu.m/day/feddan is only supplied to a field.

B-2.6. Water Qualities of Bahr Wahby

At present, water quality of Bahr Wahby is quite well for irrigation. Salinity concentration is ranging from 200 to 270 ppm on August as even low water period, because the water source of the water is Nile water. (refer to Fig. B2-6)

However, after completion of the Re-use Water Project, salinity concentration will be increased up to around 800 ppm because of mixing drainage water. As mentioned before, the salinity automatic recorder will be able to check water quality in Bahr Wahby.

Table B2-1 Discharge to Fayoum Governorate

(Unit : MCM)

Month	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean*
Jan.	11.8	13.2	3.4	30.5	54.4	37.0	72.0	121.9	35.5	65.5	67.9	63.5	63.2	64.0	59.9
Feb.	109.1	117.4	133.6	142.8	92.8	144.2	157.8	151.0	163.4	154.8	151.0	152.8	152.3	148.0	153.7
Mar.	190.5	155.6	170.2	169.0	194.5	189.7	177.4	229.6	196.7	207.0	198.8	198.0	195.7	202.1	199.7
Apr.	169.1	141.1	161.9	147.4	179.8	188.6	169.2	210.3	197.5	203.2	196.0	198.5	188.8	199.1	197.2
May	177.1	155.0	166.5	167.5	202.5	204.4	189.0	206.8	193.3	212.0	194.3	205.3	202.5	207.3	202.5
Jun.	210.4	184.5	193.8	206.2	226.1	223.4	208.1	213.0	211.2	216.7	212.5	214.1	207.0	215.2	212.8
Jul.	240.8	228.6	233.5	233.5	255.1	241.8	232.1	220.6	239.7	259.7	244.7	247.5	241.6	250.0	247.2
Aug.	235.9	226.4	229.6	234.3	257.2	239.1	225.7	188.2	255.6	235.9	250.2	251.0	245.9	245.6	247.4
Sep.	189.2	192.7	194.0	202.1	210.3	194.2	172.8	196.1	220.9	230.7	214.9	209.2	212.7	216.5	217.5
Oct.	166.7	168.5	177.2	180.4	186.0	183.2	159.1	179.9	211.4	209.0	189.8	185.6	194.0	216.3	201.0
Nov.	149.8	150.8	163.7	182.1	196.3	172.0	145.4	186.3	201.5	200.0	185.1	183.9	190.2	190.2	191.8
Dec.	130.8	131.1	124.4	177.9	178.5	162.1	138.6	172.2	171.5	181.4	178.8	155.0	168.3	169.0	170.7
Total	1981.2	1864.9	1951.8	2073.7	2233.5	2179.7	2047.2	2175.9	2298.2	2375.9	2284.0	2264.4	2262.2	2323.3	2301.4

Water duty: Annual avarage 20.0 cu.m/day/feddan = 2301.4 MCM / 315000 feddan / 365 days

Monthly max. 25.3 cu.m/day/feddan = 247.4 MCM / 315000 feddan / 31 days

Note: * The mean values are calculated based on the past six years from 1978 to 1983.

Source: 1970 to 1971: M.O.I., Fayoum. 1972 to 1975: M.O.I., Cairo.

1976 to 1983: M.O.I., Fayoum.

Table B2-2 Drain Discharge of Main Drains

(Unit: cu.m/sec)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
--- Batts Drain ---													
1975	2.27	6.63	6.10	5.38	6.34	5.64	5.04	6.79	6.46	7.10	7.38	8.51	6.13
	11.02	0.54											
1980	0.84	12.41	7.62	8.30	8.77	5.80	5.93	NA	10.80	9.90	8.35	10.39	NA
1981	9.96	6.25	7.31	8.31	6.68	5.96	6.21	6.74	NA	7.68	NA	NA	NA
--- Wadi Drain ---													
1975	1.95	4.86	3.24	2.01	2.86	1.32	0.91	1.50	2.56	2.53	3.50	5.05	2.68
1980	2.80	5.35	4.67	5.12	7.72	1.45	2.93	NA	5.85	5.76	8.24	7.88	NA
1981	NA	3.71	4.93	NA	NA	1.40	NA	4.43	4.06	5.52	NA	NA	NA
--- Wadi El Rayan ---													
1975	1.95	3.94	8.15	8.26	8.60	8.28	8.15	8.51	8.63	8.36	8.68	8.20	7.49
1980	NA	4.56	5.13	8.99	9.91	8.72	6.62	NA	13.43	8.82	6.95	10.04	NA
1981	NA	7.74	NA	10.20	9.30	NA	7.20	NA	8.19	9.40	10.10	NA	NA

Note: 1. The figures with asterisk mark mean that two times measurement were carried out in the first and second half of the month. (during and after the water closure period)

2. NA means that a measurement work was not carried out during this month.

Source: Data of 1975 are taken from the report of Hydrology of Lake Qarun and data of 1980 and 1981 from the report of Re-Use of Drainage Water for Agricultural Purposes in Fayoum, December, 1981.

Table B2-3 Length and Catchment Area directly poured to Lake Qarun

Name of Drain	Length (km)	Drainage Area (sq.km)	Drainage Area (Feddans)
A. Lake Qarun Basin			
1. Batts Drain	50.85	637.75	151845
2. Wadi Drain	39.67	(491.40) 735.00	(117000) 175000
Sub-total	90.52	(1,129.15) 1,372.75	(268845) 326845
3. Abo Harawa	5.77	10.50	2500
4. Batts Saied	4.25	33.60	8000
5. Abo Tarfaya	6.22	6.72	1600
6. Koor El Hetan	3.81	5.88	1400
7. Hedodet Tersa	9.70	8.82	2100
8. El Shaike Allam	7.63	36.12	8600
9. Hedodet Abshway	7.60	8.40	2000
10. El Mesharrak	7.12	8.40	2000
11. Al Eslah	1.96	1.17	279
12. El Hammam	4.27	8.40	2000
13. Battn Ihreet	8.91	25.20	6000
14. Kota Drain	4.25	8.40	2000
Sub-total	71.49	161.61	38479
Total	162.01	(1,290.76) 1,534.36	(307324) 365324
B. Lake Rayan Basin			
1. Wadi El Rayan		(243.60)	(58000)
Total		(243.60)	(58000)
Grand Total		1,534.36	365324

Note: 1. Figures in brackets mean estimated drainage area excluding the drainage area of El Wadi Rayan Canal.

2. Conversion rate of 0.42 ha/feddan is used to calculate drainage area in sq.km. The original data is shown in feddans.

Source: MOI, Fayoum

Table B2-4 Drains Discharge to Lake Qarun

(Unit : MCM)

Month	1970*	1971*	1972	1973	1974	1975	1976	1977*	1978*	1979*	1980*	1981	1982	1983	Mean
Jan	17.1	14.3	8.6	6.8	7.1	13.5	22.6	9.3	9.8	13.1	12.2	25.1	14.4	13.3	13.9
Feb	23.6	19.7	18.3	32.4	8.9	22.5	26.1	12.8	13.5	18.0	16.8	23.8	16.0	4.7	19.1
Mar	37.4	31.3	34.3	31.1	26.6	28.6	26.0	20.3	21.4	28.6	26.7	37.6	31.3	27.2	30.3
Apr	31.0	25.9	30.7	29.4	19.0	18.7	18.6	16.8	17.7	23.7	22.1	30.3	28.2	25.9	25.1
May	32.4	27.1	32.1	24.1	20.4	24.0	23.8	17.6	18.6	24.8	23.2	30.2	26.5	29.2	26.3
Jun	27.4	22.9	28.8	16.4	19.8	18.6	18.4	14.9	15.7	21.0	19.5	26.4	22.5	27.0	22.2
Jul	29.0	24.2	27.6	31.8	18.8	15.5	22.0	15.7	16.6	22.2	20.7	24.7	20.6	27.1	23.5
Aug	30.0	25.1	27.4	34.3	20.4	20.8	20.7	16.3	17.2	22.9	21.4	27.3	19.7	23.5	24.3
Sep	33.7	28.2	32.1	41.6	32.6	22.7	22.5	18.3	19.3	25.8	24.0	27.9	18.7	20.2	27.3
Oct	37.0	30.9	34.8	39.5	31.8	25.5	25.4	20.1	21.2	28.3	26.4	30.9	26.4	25.9	30.0
Nov	39.2	32.8	36.0	41.6	34.6	26.6	26.5	21.3	22.5	30.0	28.0	30.1	29.1	30.0	31.8
Dec	52.4	43.9	50.6	52.3	43.9	33.6	44.9	28.5	30.0	40.1	37.5	41.4	39.3	34.3	42.5
Total	390.2	326.3	361.3	381.2	283.8	270.6	297.5	211.9	223.5	298.5	278.5	355.7	292.7	288.3	316.3

Note: On the year with * mark, only annual data is available. The monthly data is estimated as follows. The monthly percentage against the annual mean value is applied to estimate the monthly values.

Example.. in 1970 Jan. (13.9/316.3)*390.2=17.1

The annual mean discharge from 1974 to 1983 is calculated at 280.1 MCM.

Source; 1972 - 1976: M.O.I., Cairo.
1977 - 1983: M.O.I., Fayoum.

Table B2-5 Monthly Discharge of Bahr Wahby (at Seka Hadid weir)

(Unit: MCM)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1980	5.85	18.18	26.95	25.87	27.66	26.46	30.33	32.11	29.86	22.85	22.03	21.84	289.99
1981	8.23	26.72	28.79	29.32	28.80	31.41	34.47	37.71	31.43	27.20	27.60	27.48	339.16
1982	8.11	22.90	29.15	27.60	28.04	30.14	33.12	32.27	28.94	28.25	29.61	28.98	327.11
1983	6.86	19.47	26.81	25.59	24.09	25.28	30.23	26.64	23.69	26.45	24.82	24.31	284.54
1984	7.23	19.60	27.88	26.90	23.70	26.80	31.89	28.59	NA	NA	NA	NA	NA
Mean	7.26	21.37	27.92	27.06	26.46	28.02	32.01	31.46	28.48	26.19	26.02	25.65	310.20

Note: In 1980,'83 and '84, amount of discharge are equivalented based on water depth on the crest of Seka Hadid weir which has a service area of 59,972 feddans.
NA means that the data is not available.

Source: Those basic data were presented by MOI, Fayoum, 1984

Table B2-6 Monthly Water Duty of Bahr Wahby (at Seka Hadid weir)

(Unit: cu.m/day/feddan)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1980	3.1	10.8	14.5	14.4	14.9	14.7	16.3	17.3	16.6	12.3	12.2	11.7	13.2
1981	4.4	15.9	15.5	16.3	15.5	17.5	18.5	20.3	17.5	14.6	15.3	14.8	15.5
1982	4.4	13.6	15.7	15.3	15.1	16.8	17.8	17.4	16.1	15.2	16.5	15.6	14.9
1983	3.7	11.6	14.4	14.2	13.0	14.1	16.3	14.3	13.2	14.2	13.8	13.1	13.0
1984	3.9	11.3	15.0	14.5	12.7	14.9	17.2	15.4	NA	NA	NA	NA	NA
Mean	3.9	12.6	15.0	14.9	14.2	15.6	17.2	16.9	15.9	14.1	14.5	13.8	14.2

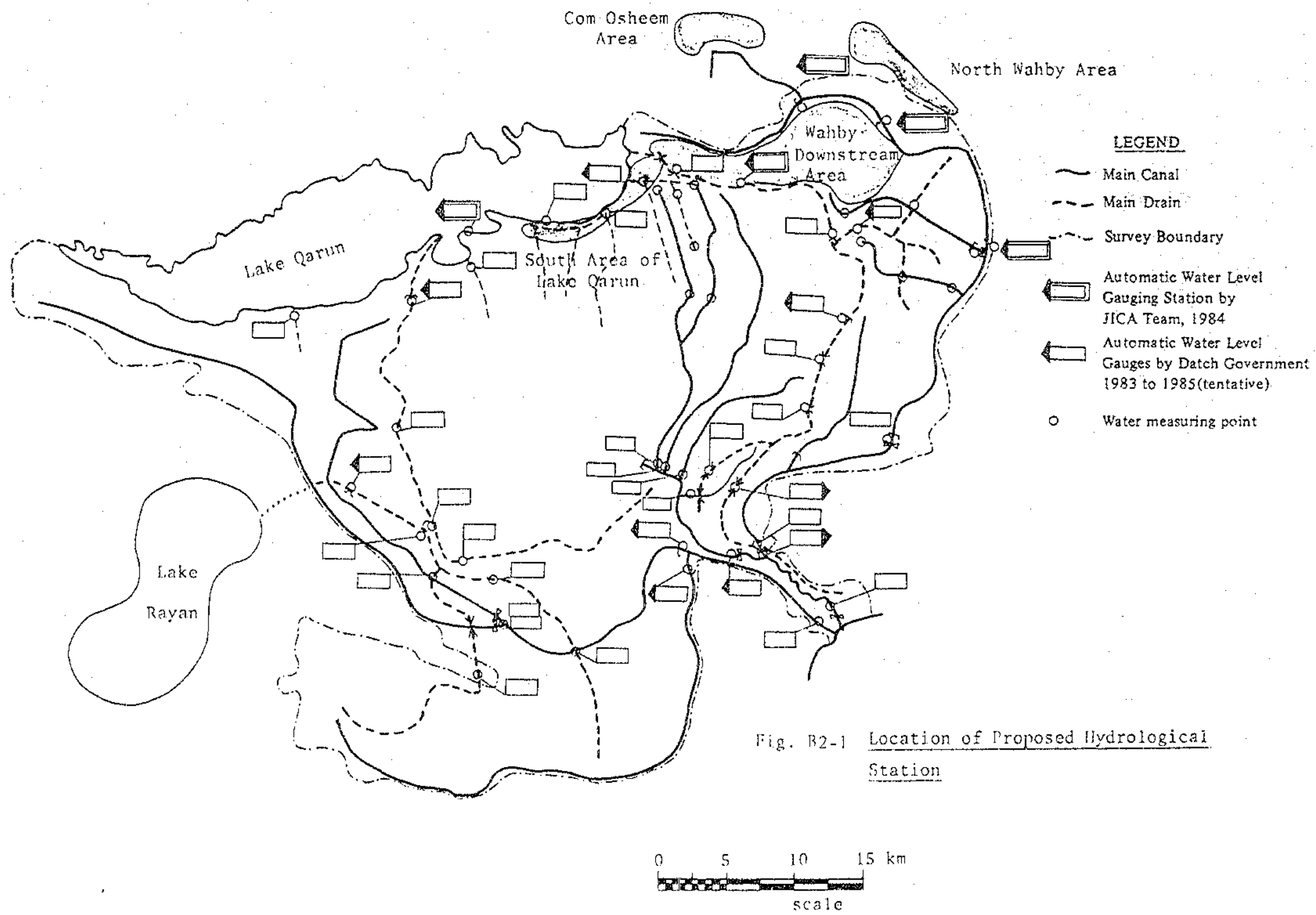


Fig. B2-1 Location of Proposed Hydrological Station

Fig. B2-2. SCHEMATIC LAYOUT OF IRRIGATION SYSTEM IN FAYOUM

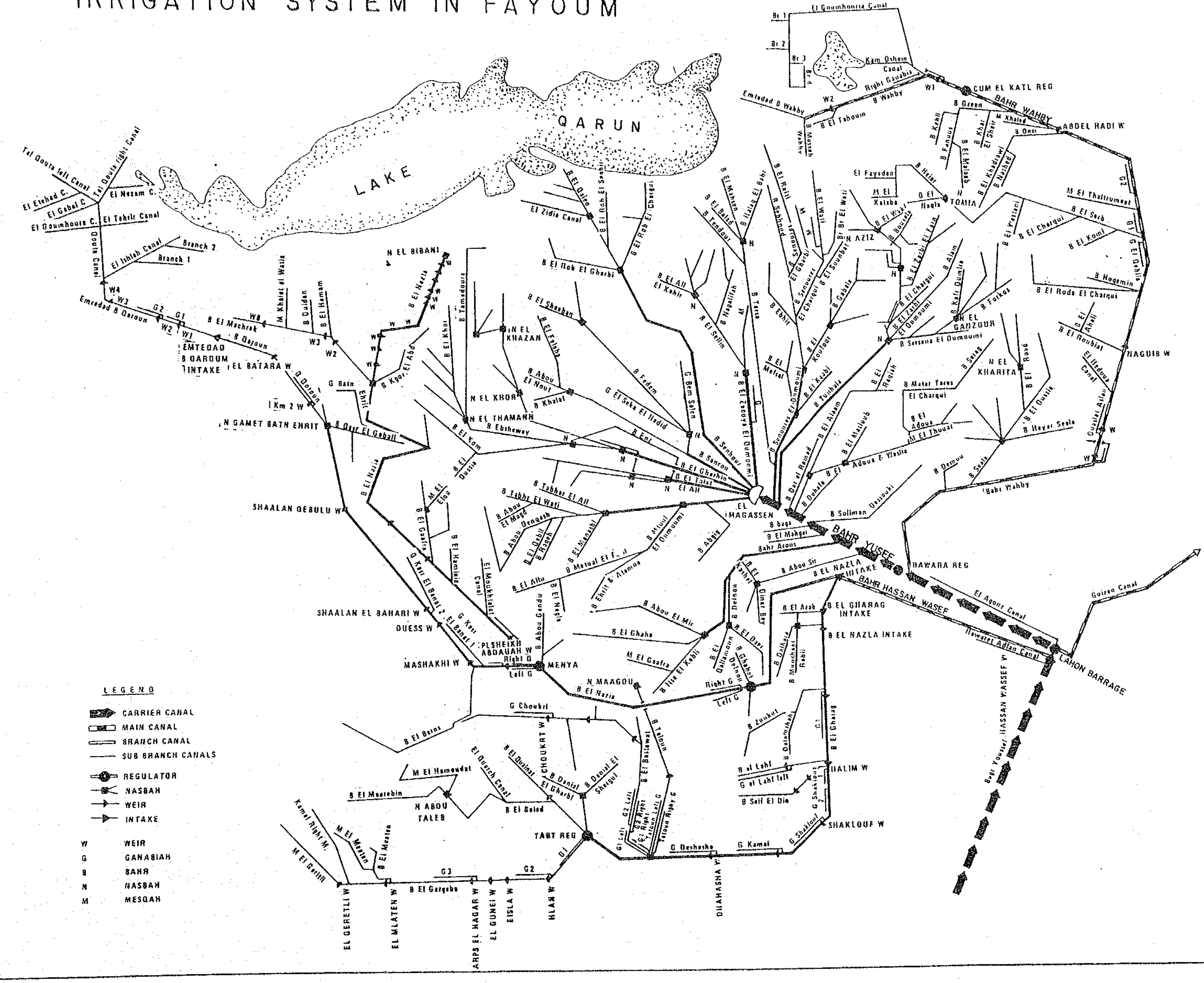
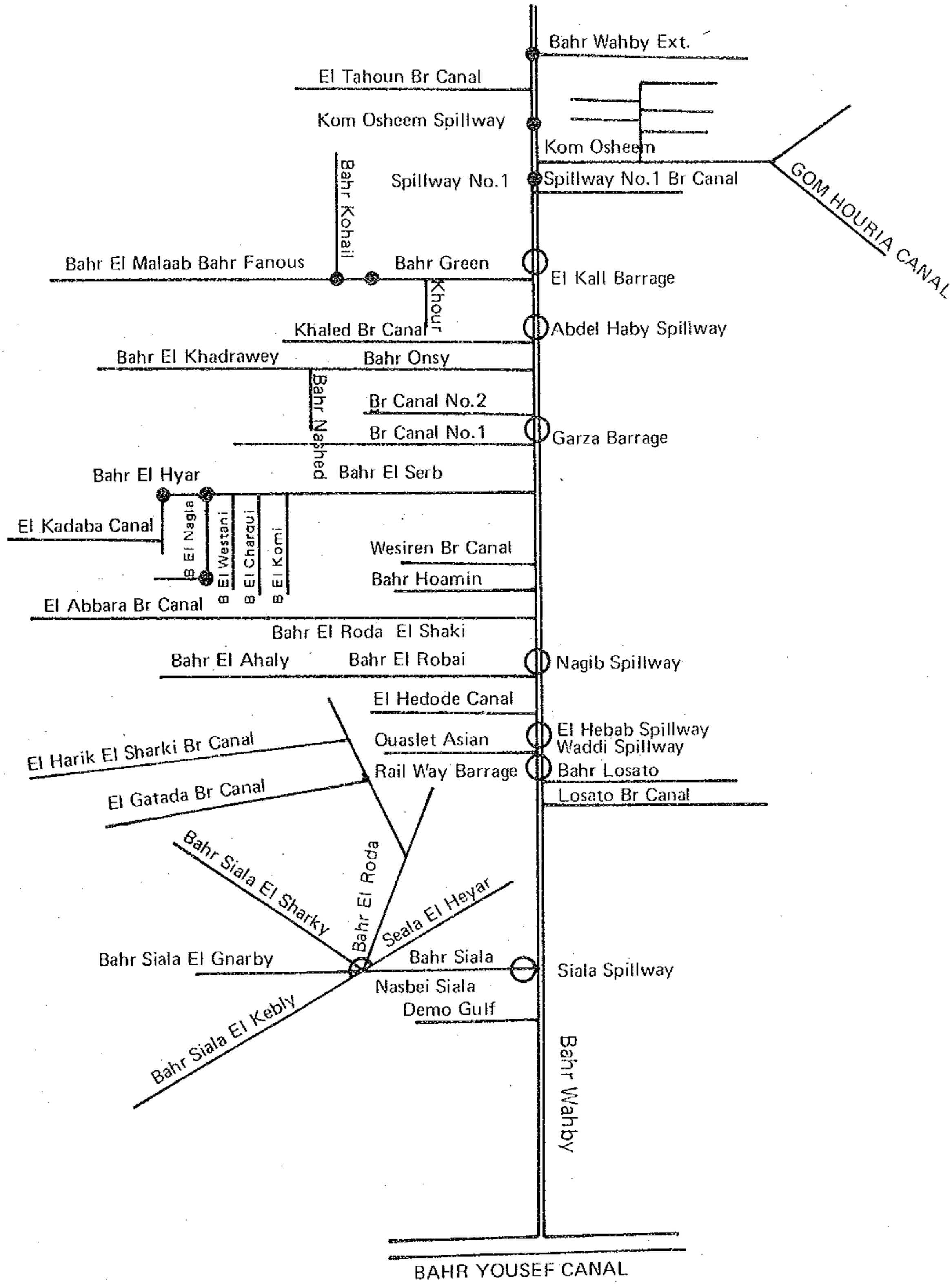


Fig.B2-3 SCHEMATIC DIAGRAM OF BAHR WAHBY



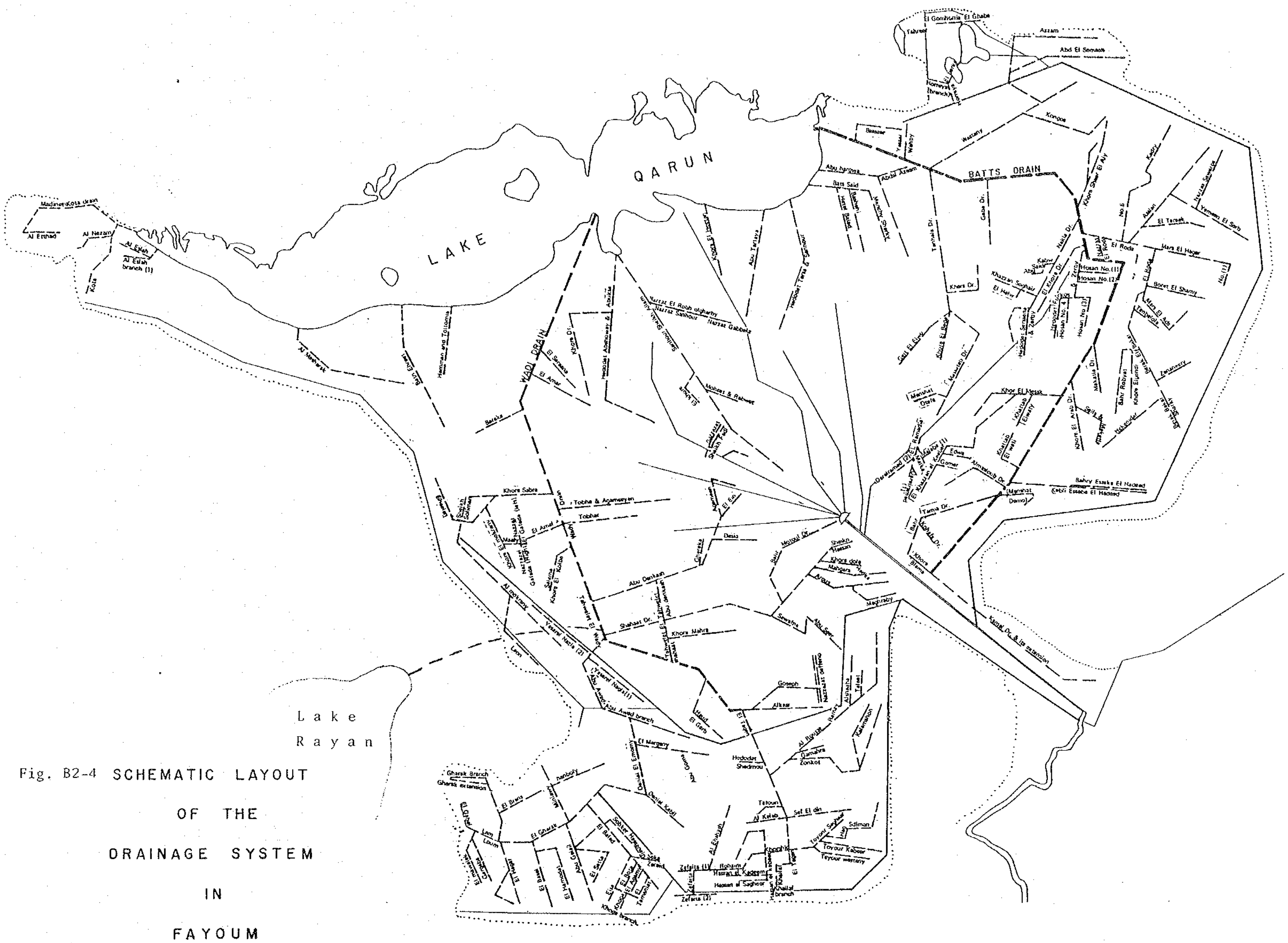
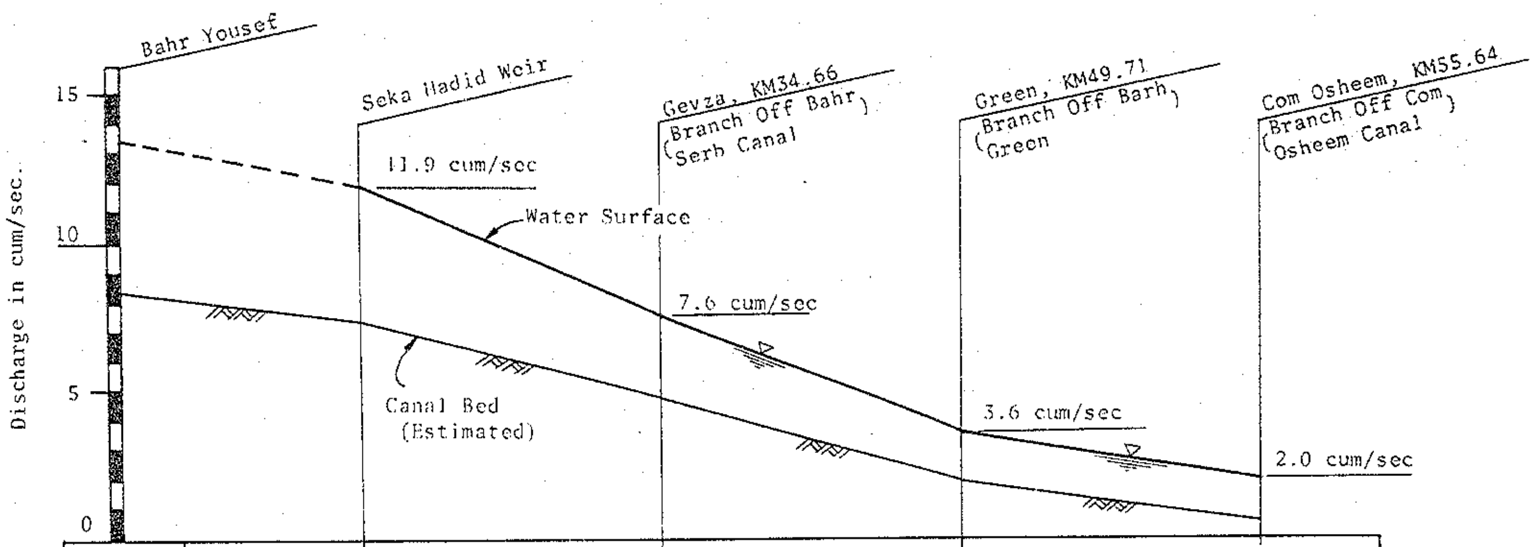


Fig. B2-4 SCHEMATIC LAYOUT OF THE DRAINAGE SYSTEM IN FAYOUM

Fig. B2-5 Longitudinal Discharge Distribution

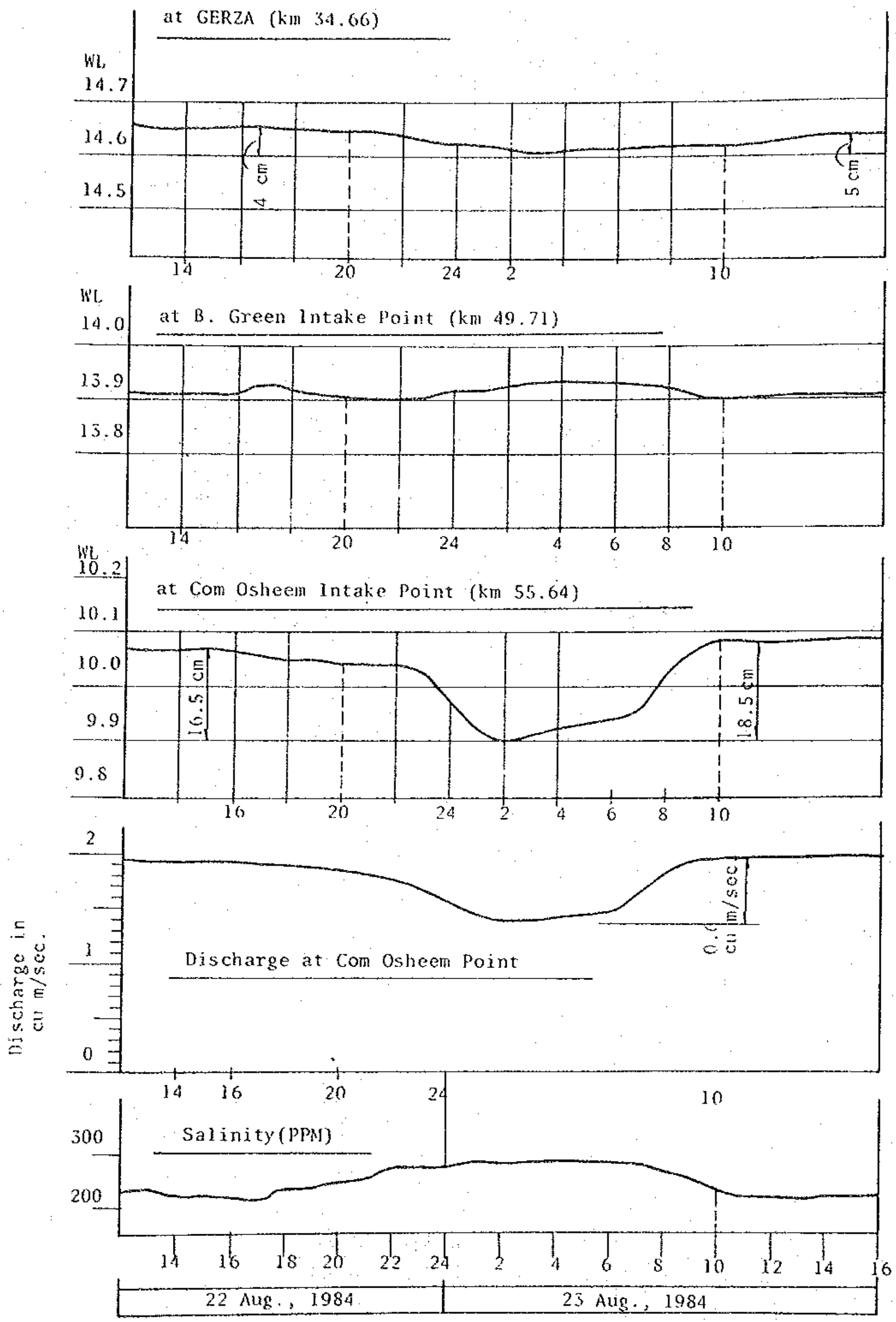


Water Duty (cum/day/feddan)	(C)	17.1	20.7	13.9	15.6
Area served (feddan)	(B)	60,000	31,747	22,410	11,050
Discharge (cum/sec)	(A)	11.9	7.6	3.6	2.0

Note: C = A x 86,400/B

(Aug., 1984)

Fig. B2-6 Hydrograph of Bahr Wahby



Note: Salinity data was collected on 27th Aug., 1984

B-3. Water Balance of Lake Qarun

B-3.1. General

The MOI recognizes the need for improving its current procedures for calculating the water balance of the Fayoum basin. In collaboration with Dutch consultants and operating under the guidance of the Dutch-Egyptian Advisory Panel on Land Drainage, the Drainage Research Institute (DRI) of the MOI has set up a three-year (1983 - 85) project for the elaborating of a mathematical model of the salt and water balance of the distinct areas of the Fayoum basin. The DRI has commenced a program of data collection on irrigation water supplies and water distribution at strategic points; on quantities and qualities of drainage outflows at 16 monitoring stations; and on related on-farm water management and agricultural practices.

The project funded water management in the demonstration area would supplement the efforts of the DRI in determining the effects that changes in water management, land levelling, and improved agricultural practices would have on the water and salt balance. The model would make it possible to test the effects of different land and water management options on the quantities and qualities of drainage water, and to effectuate improved water management in the Area. It would also allow the appropriate diversion of the drainage flow to the Wadi Rayan depression in relation to the required stabilization of the water level in Lake Qarun.

B-3.2. Fluctuation of Water Level

As well known, Lake Qarun has a closed drainage system, so that outlet of lake water is only by evaporation. In usually, the maximum water level appears in March or April and the minimum in September or October.

According to the discharge records at the Lahorn barrage, an amount of water supplied to Fayoum is slightly increased during a period from 1970 to 1983. And this period is divided into three stages, namely, the first stage before 1973 without the Wadi El Rayan open channel, the second stage from 1974 to 1977 as the initial stage to commence diverting part of drainage water through the channel and the recent stage from 1978 to the present diverting the drainage water through the said channel. The construction of the Wadi El Rayan open channel intended to divert part of drain water from the Fayoum depression to Lake Rayan for controlling the water level of Lake Qarun and to increase the water supply to Fayoum depression from the Nile river.

The stage before 1973 means that the Wadi El Rayan channel not yet constructed to divert part of drain water in the Fayoum depression to Lake Rayan. During this stage, the amount of water of 1,968 MCM was annually supplied to the Fayoum depression and the amount of 365 MCM was annually drained to Lake Qarun. The annual mean water level of Lake Qarun was slightly going up.

During the second stage from 1974 to 1977, part of drainage water with the amount of drainage discharge of 155 MCM was diverted to Lake Rayan. The amount of drainage discharge to Lake Qarun was decreased to 266 MCM. So, the total annual amount of drainage water to both Lake Qarun and Rayan reached to 421 MCM. On the other hand, the amount of water supplied to the Fayoum depression was slightly increase to 2,159 MCM. A decreasing ratio of drain water to Lake Qarun against the former amount of 365 MCM is 73 percent. The annual mean water level of Lake Qarun became lower.

On the recent stage after 1978, notwithstanding part of drainage water in the Fayoum depression is continuously being diverted to Lake Rayan through the said channel, the water level of Lake Qarun was going up. As for the reasons, it is supposed that increasing the amount of water supplied to the Fayoum depression to about 2,300 MCM and decreasing extent of evaporation from the water surface of Lake Qarun due to slightly unusual meteorological conditions such as low temperature and other unknown factors. (refer to Figure B3-3 and Table B3-7 in this Appendix B)

In 1984 and 1981, the maximum water level was higher than that of other years. The mean maximum water level is recorded at -43.55 m and the minimum one at -44.03 m and the annual mean water level at -43.76 m. (refer to Tables B3-1 and B3-2, and Fig. B3-1)

The monthly fluctuation of the water level of the Lake is not so big, which becomes less than ten centimeters during the maximum and minimum water level period. During the transition period between the high water stage and the low stage the said monthly fluctuation is observed at about 20 cm. (refer to Table B3-3)

B.3-3. Water Balance with the Project

For studying water balance of the whole Fayoum area, the simplified hydrological mathematics model will be employed. As the inflow data, discharge records to flow into the Governorate, rainfall, drainage discharge, and so on will be used.

As input data for calculation, consumptive use of each crops, inflow discharge to Fayoum governorate, inflow discharge of groundwater to the Lake, cropped acreage, domestic water supply, discharge to Lake Rayan, Evaporation from Lake Qarun and irrigation efficiency will be used. As verification data, the water levels observed at Shakshok will be applied. However, among the above the some data like cropped acreage are assumed and not reliable.

So, the water balance study was carried out by using only lake water level, stored water volume, drainage discharge to Lake Qarun and amount of water to intake from the drainage canal in 1976 as the standard year because monthly water level of 1976 is quite similar to that of the mean water level of the Lake from 1960 to 1983.

After completion of the Re-use Water Pump Project, the maximum amount of discharge of 4.59 cu.m/sec will be take off from the Batts drain and the amount of drainage discharge in the drain will be decreased. The monthly discharge to be taken at Tamiah for the irrigation purpose is described in Table F2-9 in Appendix F-2. But that amount of discharge is not including irrigation requirement for the water shortage area of Wahby Downstream Area. The requirement is estimated at the same with the amount of water for both new reclamation areas when the total amount does not reach to the pump capacity of 4.59 cu.m/sec (= 1.53 cu.m/sec x 3 units).

Taking future conditions into consideration, two cases of alternatives were studied for the water balance of Lake Qarun. In the first case, no supplemental water from the Nile river was considered. Re-use water of 4.59 cu.m/sec in the maximum period would be taken from the Batts drain and the gross area of the newly reclaimed area would be about 8,800 feddan in North Wahby and Com Osheem areas. The same amount of irrigation water for the both areas would be given to the water shortage area of Wahby Downstream area. This case is called as without add (w/o add).

In the another case that a stable supplemental amount of 2.2 cu.m/sec is available in order to keep certain water level of Lake Qarun as same as that of the standard year of 1976 which is called as present, the same above items were considered. This case is called as with add (w/ add).

In the former case, according to the calculation the water level will be lowered to 28 cm against the present on the month when the minimum water level will be occurred and in the latter case that will be only one centimeter.
(refer to Fig. B3-2 and Tables B3-4, B3-5 and B3-6)

Table B3-1 Evaporation Rates from Open Water Surfaces and Lake Qarun

Month	Fayoum average evaporation (mm/day)	Lake Qarun average evaporation (mm/day)
January	3.4	2.1
February	4.4	4.1
March	6.0	5.5
April	8.6	7.9
May	11.8	10.9
Jun	13.3	12.3
July	11.8	10.9
August	10.1	9.3
September	8.0	7.4
October	6.0	5.5
November	4.5	4.1
December	3.2	2.9
Average mm/day	7.6	7.0 (1)

1) This figure was taked from "Exploitation of salts from lake Qarun" by White - Young & Parthers - 1980 and monthly figures for Lake Qarun was then extrapolated.

Table B3-2 Mean Water Level of Lake Qarun

(Unit: m)

Month	Jan (m)	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1960	-44.03	-43.99	-43.92	-43.90	-43.54	-44.09	-44.24	-44.38	-44.46	-44.45	-44.36	-44.19	-44.17
1961	-44.11	-44.08	-44.02	-44.00	-44.00	-44.10	-44.25	-44.38	-44.45	-44.46	-44.26	-44.19	-44.18
1962	-43.94	-43.93	-43.87	-43.95	-43.91	-44.03	-44.14	-44.26	-44.34	-44.34	-44.28	-44.17	-44.08
1963	-44.07	-44.06	-44.01	-44.01	-44.02	-44.04	-44.15	-44.25	-44.30	-44.30	-44.25	-44.13	-44.13
1964	-44.01	-44.02	-43.98	-43.98	-43.99	-44.06	-44.15	-44.23	-44.30	-44.29	-44.22	-44.05	-44.11
1965	-43.92	-43.94	-43.89	-43.86	-43.88	-43.97	-44.08	-44.18	-44.25	-44.26	-44.20	-44.06	-43.96
1966	-44.00	-43.98	-43.90	-43.86	-43.91	-43.98	-44.10	-44.20	-44.26	-44.28	-44.22	-44.10	-44.07
1967	-43.94	-43.90	-43.89	-43.92	-44.00	-44.10	-44.19	-44.26	-44.27	-44.21	-44.10	-44.00	-44.05
1968	-43.98	-43.96	-43.92	-43.93	-43.96	-44.03	-44.13	-44.18	-44.16	-44.07	-43.92	-43.81	-43.96
1969	-43.75	-43.67	-43.65	-43.70	-43.81	-43.94	-44.03	-44.08	-44.10	-44.23	-44.10	-43.84	-43.88
1970	-43.84	-43.83	-43.79	-43.80	-43.86	-43.94	-44.01	-44.05	-44.04	-43.97	-43.81	-43.70	-43.89
1971	-43.70	-43.70	-43.57	-43.64	-43.64	-43.71	-43.81	-43.89	-43.95	-43.97	-43.92	-43.79	-43.77
1972	-43.71	-43.69	-43.64	-43.60	-43.60	-43.65	-43.74	-43.83	-43.85	-43.84	-43.74	-43.56	-43.70
1973	-43.71	-43.45	-43.40	-43.40	-43.46	-43.58	-43.72	-43.87	-43.95	-43.96	-43.94	-43.81	-43.67
1974	-43.49	-43.35	-43.58	-43.59	-43.65	-43.75	-43.85	-43.99	-44.04	-43.99	-43.99	-43.82	-43.80
1975	-43.67	-43.61	-43.57	-43.57	-43.64	-43.75	-43.86	-43.99	-44.10	-44.14	-44.11	-43.98	-43.83
1976	-43.82	-43.77	-43.71	-43.69	-43.73	-43.84	-43.98	-44.11	-44.21	-44.22	-44.16	-44.10	-43.94
1977	-43.72	-43.59	-43.63	-43.66	-43.67	-43.72	-44.37	-44.55	-44.17	-44.23	-44.23	-44.10	-43.97
1978	-44.05	-43.80	-43.77	-43.77	-43.79	-43.87	-44.06	-44.26	-44.30	-44.32	-44.24	-44.03	-44.01
1979	-43.74	-43.65	-43.59	-43.54	-43.59	-43.74	-43.87	-43.99	-44.04	-44.03	-43.90	-43.69	-43.78
1980	-43.42	-43.35	-43.31	-43.29	-43.34	-43.44	-43.55	-43.70	-43.79	-43.82	-	-	-43.54*
1981	-43.39	-43.30	-43.22	-43.20	-43.25	-43.37	-43.55	-43.70	-43.78	-43.82	-43.82	-43.71	-43.51
1982	-43.54	-43.47	-43.47	-43.47	-43.50	-43.74	-43.83	-43.89	-43.99	-44.01	-43.95	-43.77	-43.72
1983	-43.60	-43.61	-43.53	-43.44	-43.45	-43.52	-43.66	-43.78	-43.89	-43.91	-43.75	-43.53	-43.64
Mean	-43.80	-43.74	-43.70	-43.70	-43.72	-43.83	-43.97	-44.08	-44.13	-44.13	-44.06	-43.92	-43.89
Mean*	-43.64	-43.55	-43.54	-43.52	-43.56	-43.67	-43.86	-44.00	-44.03	-44.05	-44.02	-43.86	-43.77

Note: - means that no data is available. * mark means an estimated figure.
Underlines mean the maximum water level in the year.
Then mean values with * mark are the average from 1974 to 1983.

Source: M.O.I , Fayoum

Table B3-3 Fluctuation of Water Level in Lake Qarun
(between 1st day and last day of the month)

(Unit: mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	+ 25	- 15	+ 45	+ 5	- 10	- 40	- 55	- 40	+ 5	+110	+ 80	+150
1971	+ 10	- 5	+ 35	+ 30	- 15	- 65	- 70	- 40	- 25	zero	+ 50	+110
1972	+ 20	+ 5	+ 50	+ 20	-101	- 50	- 70	- 45	zero	+ 5	+ 55	+120
1973	- 5	+ 85	+ 10	- 10	- 35	-105	-110	-110	- 15	- 15	+ 5	*
1974	- 90	+ 5	+ 30	- 20	- 45	- 45	- 95	- 70	- 10	zero	+ 40	+165
1975	+ 60	+ 30	+ 30	- 20	- 25	- 45	- 85	- 85	- 65	- 5	+ 30	+135
1976	+ 90	+ 35	+ 45	zero	- 45	- 80	- 85	-110	- 40	+ 10	+ 35	*
1977	+145	+ 20	- 70	- 5	+ 15	- 45	- 90	- 95	- 65	+ 50	+ 25	+115
1978	+240	zero	+ 45	- 20	- 10	- 65	-165	- 55	- 15	zero	+120	+200
1979	+180	+ 10	+ 80	+ 25	- 70	- 95	- 80	- 70	- 15	+ 55	+155	+190
1980	+ 90	+ 10	+ 30	+ 10	- 65	- 50	-200	-130	zero	+ 25	+ 25	+210
1981	+125	+ 95	+ 45	- 10	- 90	-180	-135	-115	- 50	- 5	+ 10	+205
1982	+105	+ 25	zero	+ 5	- 85	-190	- 50	- 95	- 80	+ 50	+ 55	+265
1983	+ 95	- 40	+145	+ 20	zero	-135	-155	-130	- 55	+ 50	+200	+250

Note: * No data is available

Source: 1970 - 1981 M.O.I., Cairo
1982 - 1983 M.O.I., Fayoum

Table B3-4 Calculation of Water Balance of Lake Qarun

Month	Water Level(3) (m)	Volume(4) (MCM)	Change Volume (MCM)	Re-use(2) Water (MCM)	Change w/ Re-Use W. (MCM)	Volume w/ R.U.W (MCM)	Suppl. To Lake (MCM)	Change w/ S.T.L (MCM)	Volume w/ S.T.L (MCM)
JAN.	-43.82	1,022	0	6	- 4	1,018	6	+ 2	1,024
FEB.	-43.77	1,034	+12	11	+ 5	1,023	6	+11	1,035
MAR.	-43.71	1,049	+15	9	+ 9	1,032	6	+15	1,050
APR.	-43.69	1,054	+ 5	8	0	1,032	6	+ 6	1,056
MAY	-43.73	1,043	-11	12	-19	1,013	6	-13	1,043
JUN.	-43.84	1,018	-25	12	-32	981	6	-27	1,016
JUL.	-43.98	985	-33	13	-41	940	7	-34	982
AUG.	-44.11	955	-30	12	-38	902	6(1)	-32	950
SEP.	-44.21	932	-23	6	-27	875	6	-21	929
OCT.	-44.22	930	- 2	9	- 8	867	6	- 2	927
NOV.	-44.16	943	+13	6	+ 9	876	6	+15	942
DEC.	-44.10	957	+14	7	+ 9	885	6	+15	957
Total			-65	110	-137	-137	110		

Note: (1) 6 MCM / 31 days / 86,400 = 2.2 cu.m/sec

(2) According to Table F2-9 in Appendix F-2 plus water requirement for a water shortage area of Wahby Downsteam Area. But the maximum water requirement is 4.59 cu m/sec (= 1.53 cu m/sec x 3 units).

(3) Water level on 1976

(4) According to Tables B3-5 and B3-6

Table B3-5 Water Level and Water Surface Area of Lake Qarun

(Unit;sq.km)

Level (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-43.00	251.9	251.6	251.4	251.1	250.9	250.6	250.4	250.2	249.9	249.7
.10	249.4	249.2	249.0	248.8	248.5	248.3	248.1	247.9	247.7	247.5
.20	247.3	247.1	247.0	246.8	246.7	246.6	246.4	246.3	246.1	246.0
.30	245.9	245.7	245.6	245.4	245.2	245.1	244.9	244.8	244.6	244.4
.40	244.3	244.0	243.8	243.5	243.2	243.0	242.7	242.5	242.2	241.9
.50	241.7	241.6	241.5	241.4	241.2	241.1	241.0	240.9	240.8	240.7
.60	240.6	240.5	240.3	240.2	240.1	239.9	239.8	239.7	239.5	239.4
.70	239.3	239.1	239.0	238.8	238.7	238.5	238.4	238.2	238.0	237.9
.80	237.7	237.3	236.9	236.4	236.0	235.6	235.1	234.7	234.3	233.8
.90	233.4	233.3	233.2	233.1	233.0	232.9	232.8	232.7	232.6	232.5
-44.00	232.4	232.2	232.1	231.9	231.7	231.5	231.3	231.2	231.0	230.8
.10	230.6	230.4	230.1	229.9	229.6	229.4	229.1	228.8	228.6	228.3
.20	228.1	227.8	227.6	227.3	227.0	226.8	226.5	226.2	226.0	225.7
.30	225.4	225.1	224.8	224.5	224.1	223.8	223.5	223.2	222.8	222.5
.40	222.2	222.0	221.9	221.7	221.5	221.3	221.2	221.0	220.8	220.7
.50	220.5	220.3	220.0	219.8	219.6	219.4	219.2	218.9	218.7	218.5
.60	218.3	218.1	218.0	217.8	217.6	217.5	217.3	217.2	217.0	216.9
.70	216.7	216.5	216.3	216.1	215.9	215.7	215.5	215.3	215.1	214.9
.80	214.7	214.5	214.3	214.1	213.9	213.7	213.4	213.2	213.0	212.8
.90	212.6	212.2	211.8	211.4	211.0	210.7	210.3	209.9	209.5	209.1

Source; M.O.I., Fayoum

TAble B3-6 Water Level and Storage Capacity of Lake Qarun

(Unit; MCM)

Water Level (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
-43.00	1222.4	1219.9	1217.4	1214.9	1212.4	1209.9	1207.4	1204.9	1202.3	1199.8
.10	1197.3	1194.9	1192.4	1189.9	1187.4	1184.9	1182.4	1179.9	1177.5	1175.0
.20	1172.5	1170.0	1167.6	1165.1	1162.6	1160.2	1157.7	1155.2	1152.8	1150.3
.30	1147.8	1145.4	1142.9	1140.5	1138.0	1135.6	1133.1	1130.7	1128.2	1125.8
.40	1123.3	1120.9	1118.5	1116.1	1113.6	1111.2	1108.8	1106.3	1103.9	1101.5
.50	1099.0	1096.6	1094.2	1091.8	1089.4	1087.0	1084.6	1082.2	1079.7	1077.3
.60	1074.9	1072.5	1070.1	1067.7	1065.3	1062.9	1060.5	1058.1	1055.7	1053.3
.70	1050.9	1048.5	1046.2	1043.3	1041.4	1039.0	1036.6	1034.2	1031.8	1029.4
.80	1027.1	1024.7	1022.4	1020.0	1017.7	1015.3	1012.9	1010.6	1008.2	1005.9
.90	1003.5	1001.2	998.9	996.5	994.2	991.9	989.6	987.2	984.9	982.6
-44.00	980.2	977.9	975.6	973.3	971.0	968.7	966.3	964.0	961.7	959.4
.10	957.1	954.8	952.5	950.2	947.9	945.6	943.3	941.0	938.7	936.4
.20	934.1	931.9	930.0	927.3	925.1	922.8	920.5	918.3	916.0	913.7
.30	911.5	909.2	907.0	904.7	902.5	900.3	898.0	895.8	893.6	891.3
.40	889.1	886.9	884.7	882.4	880.2	878.0	875.8	873.6	871.4	869.2
.50	866.9	864.8	862.6	860.4	858.2	856.0	853.8	851.6	849.4	847.2
.60	845.0	842.8	840.7	838.5	836.3	834.1	832.0	829.8	827.6	825.4
.70	823.3	821.1	818.9	816.8	814.6	812.5	810.3	808.2	806.0	803.8
.80	801.7	799.6	797.4	795.3	793.1	791.0	788.9	786.7	784.6	782.5
.90	780.3	778.2	776.1	774.0	771.9	769.8	767.7	765.6	763.5	761.4

Source; M.O.I., Fayoum

Table B3-7 Discharge in and out Fayoum

(Unit: MCM)

Year	To Fayoum (1)	To Lake Qarun (2)	To Lake Rayan (3)	Total Drain D. (4=2+3)	Balance (5=1-4)
1970	1,981.2	390.2	-	390.2	1,591.0
1971	1,864.9	326.3	-	326.3	1,538.6
1972	1,951.8	361.3	-	361.3	1,590.5
1973	2,073.7	381.2	-	381.2	1,692.5
1974	2,233.5	283.8	170.7	454.5	1,779.0
1975	2,179.7	270.6	155.4	426.0	1,753.7
1976	2,047.2	297.5	141.4	438.9	1,608.3
1977	2,175.9	211.9	154.3	366.2	1,809.7
1978	2,298.2	223.5	157.9	381.4	1,916.8
1979	2,375.9	298.5	175.7	474.2	1,901.7
1980	2,284.0	278.5	194.1	472.6	1,811.4
1981	2,264.4	355.7	147.7	503.4	1,761.0
1982	2,262.2	292.7	212.7	505.4	1,756.8
1983	2,323.2	288.3	253.2	541.5	1,781.7
1984	2,301.4	316.3	N.A	N.A	N.A
Mean	2,174.5	305.1	176.3	430.2	1,735.2
Mean(a)	1,967.9	364.8	-	364.8	1,603.2
Mean(b)	2,159.1	266.0	155.5	421.4	1,737.7
Mean(c)	2,301.3	293.4	190.2	479.8	1,821.6

Note: (1) The mean values are calculated by using all available data from 1970 to 1984.

(2) The mean values with (a) are calculated by using all available data from 1970 to 1973.

(3) The mean values with (b) are calculated by using all available data from 1974 to 1977.

(4) The mean values with (c) are calculated by using all available data from 1978 to 1983 or 1984.

(5) The Wadi el Rayan channel was constructed on 1974 and was used to drain water to Lake Rayan.

Source: MOI, Fayoum

Fig. B3-1 Fluctuation of Water Level of Lake Qarun

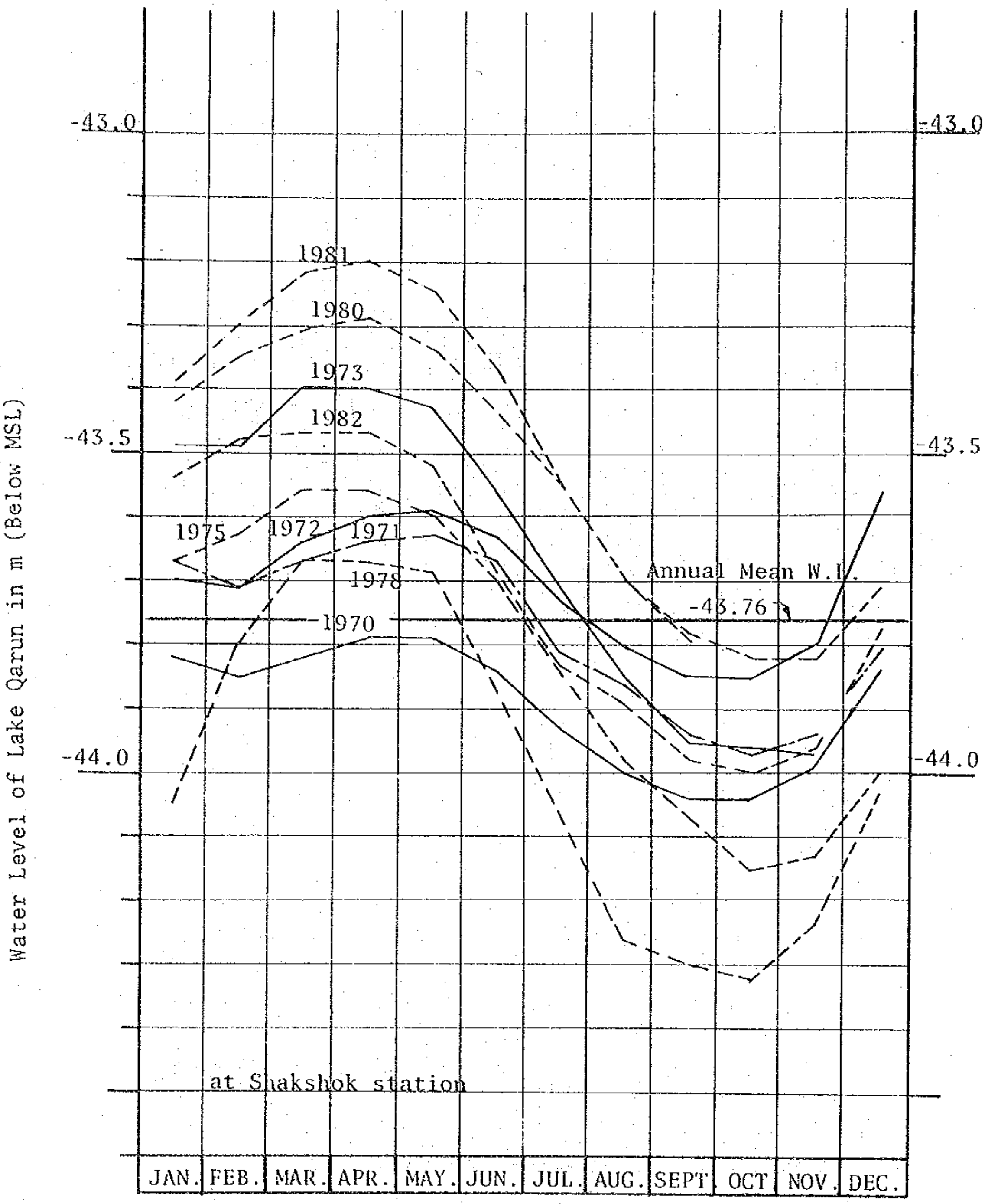


Fig. B3-2 Preliminary Water Balance of Lake Qarun

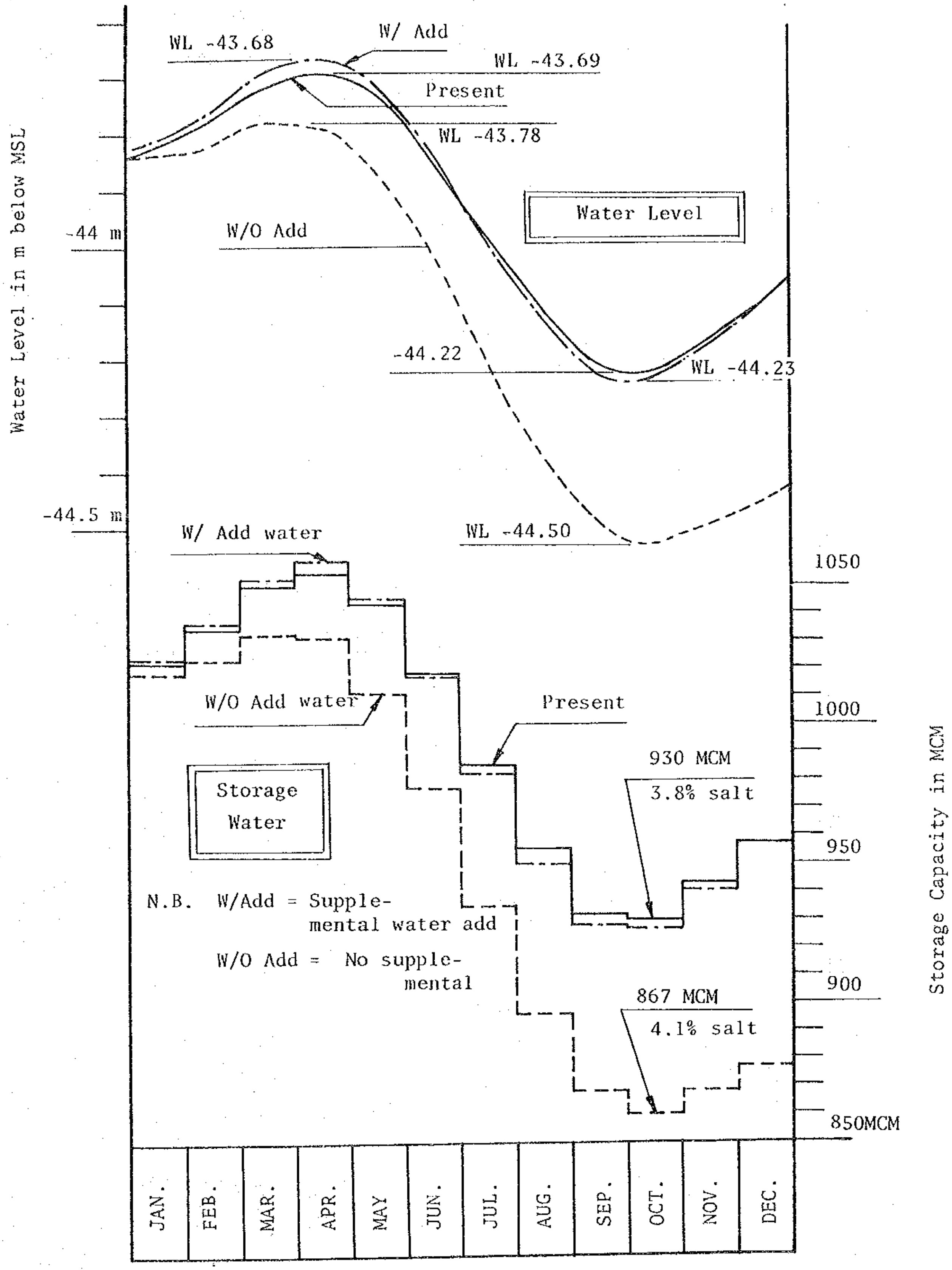
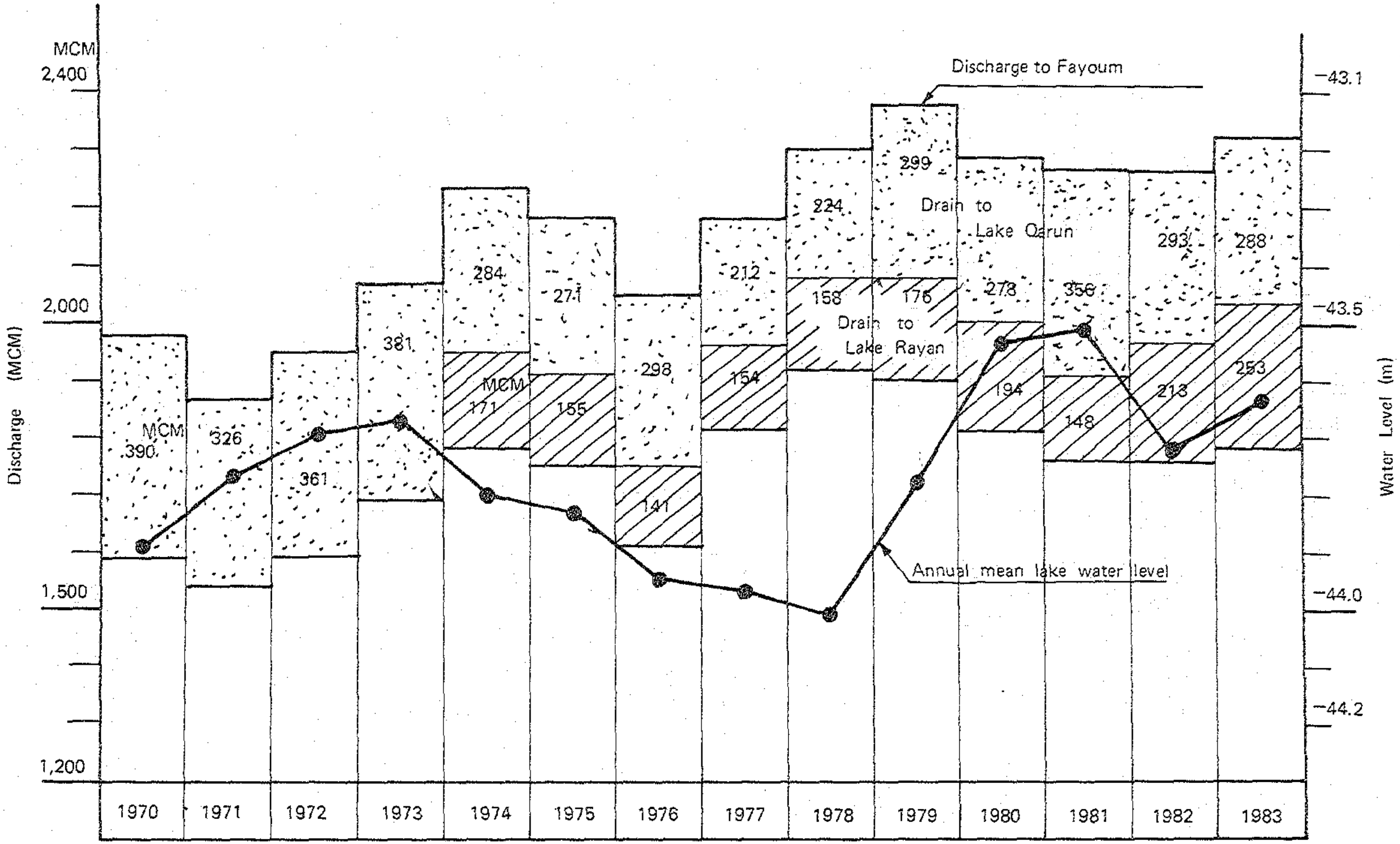


Fig. B3-3 Annual Fluctuation of Discharge and Lake Water Level



B-4. Salt Balance of Lake Qarun

B-4.1. Salt Concentration of Lake Qarun

The water quality analysis of Lake Qarun were carried out by El Nasr Salines Co., Egypt, 1976, and about 500 water samples from the 136 survey points with four layers were taken from the Lake and were analyzed at the England laboratory.

According to the results of the analysis, electric conductivity are ranging from about 3.6 to 4.8 mmhos/cm and the distribution of salt concentration is not uniformed over the Lake. An area with a radius of about six km as the center of the river mouth of the Batts drain and an area around the river mouth of Wadi drain area classified into layering area. And the other lake small area on outside of the area is classified into a high concentration area.

B-4.2. Salt Accumulation of Lake Qarun

The mean annual discharge of drain water to Lake Qarun from 1974 to 1983 after the Lake Rayan project is about 280 MCM. The salt concentration of its water is measured at 1,360 ppm. The total salt volume transferred to the Lake is estimated at about 381,000 tons per annum by using the above figures. This fact will bring about annoying problems to the people of not only the Governorate but also the Country. Because the salt concentration of Lake Qarun will be increase year by year. In other words, salt is accumulating in water of Lake Qarun. (refer to Table B4-1)

If the fish culture are not carried out in the Lake, the problem of salt accumulation in the lake is not influenced to the people. However, this country and the Fayoum Governorate aim to enhance the fish production at Lake Qarun at present. Therefore, the following idea will be considered as the countermeasures to solve above problems in near future.

- Accumulated salt should be artificially removed out of the Fayoum area.

- Salt concentration should be kept by adding fresh water from the other source to control salinity to live fishes.

The second idea is impractical. Because the after addition of fresh water the Lake water level will raise up year by year if salt concentration will be maintained a favorable circumstance for the fish culture. And also increment of water level of Lake Qarun will invalid an existing farm land. The amount of fresh water to be added to Lake Qarun should be increase but the water resources are very limited at present and in the future.

B-4.3. Future Program of Salt Manufactures

The El Nasar Salines Company in Egypt intends to construct a salt extraction plant with a capacity of 480,000 tons or 213,000 tons per year in the Abuksa bay. The plant will mainly extract 200,000 tons of NaCl, 137,000 tons of Na_2SO_4 and 200,000 tons of MaO per year. This program has a very important significant to control salt concentration of water in Lake Qarun. When the latter capacity of 213,000 tons per year will be chosen, salt of 267,000 tons per annum will be accumulated. So, the paper by Dr. Ibrahim, the Birket Qarun De-Salting Scheme (5), proposed that several dams across the Lake in north/south direction and to regulate the flow in a east/west direction. A reservoir will be used as an evaporating pond to desalt.

B-4.4. Salt Balance of Lake Qarun

There are two re-use water projects in Fayoum, which are called as the Tagen project and the Batts drain project. The former project was already implemented at the cross point of Wadi drain and Bahr El Nazla.

The Pump capacity of five cu.m/sec with six meters static head would be installed in the pumping house. The lifted drainage water would be supplemented to Bahr El Nazla in order to solve the shortage problem of an area of about 67,000 feddan such as Wahby Downstream Area.

The latter project is now on-going and is one of the main water resources for the Project in North Wahby and Com Osheem areas and Wahby Downstream Area.

Taking into consideration of above conditions, the following six alternative pans will be provable.

Case A	:	Tagen and Batts drain re-use water projects would be executed without any supplemented water
Case A-1	:	The modified Case A with additional water through drains
Case B	:	The above Case A plan plus the salt extraction plant by Nasr Saline Co. without any additional water
Case B-1	:	The modified Case B with additional water through drains
Case C	:	The above Case B plus drainage water to interrupt the Rayan open channel
Case D	:	Case A with supplemental water to interrupt the Rayan open channel

According to the results of salt balance calculation, in cases of A and B salt concentration of water in the Lake will be increment 0.8 percent of salt concentration per annum.

In Cases of A-1 and B-1 salt concentration is almost same as the present condition with 3.8 percent salt content in water of Lake Qarun. However, the amount of 179 MCM of drainage water on Case A-1 or 188 MCM on Case B-1 would be needed per year. This amounts are equivalent to 447 or 470 MCM of fresh water per year.

In case of D, the fish culture in Lake Rayan will be influenced because drainage water of 110 MCM per annum to flow Lake Rayan would be intercepted. However, the new water resources will not be necessary for this plan. When the program of Case D is performed in the future, the salt balance study as well as the water balance study in Lake Qarun and Lake Rayan should be carefully done.

Table B4-1 Salinity in Drainage Water of Main Drains

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
--- Batts Drain ---													
1970	NA	NA	NA	NA	NA	1,180	NA	2,174	1,349	1,252	1,313	969	NA
1932	NA	1,118	1,424	1,498	1,465	1,557	1,685	1,521	1,225	1,320	980	1,358	NA
1958	1,541	3,580	1,218	NA	753	1,126	1,235	1,254	1,048	NA	1,034	NA	NA
1975	1,541	1,734	1,355	1,498	1,348	1,310	1,535	1,803	1,269	1,286	1,204	1,167	1,420
--- Wadi El Rayan Drain ---													
1970	NA	NA	NA	NA	892	1,004	NA	1,880	690	808	608	1,536	NA
1932	NA	1,032	1,481	1,401	1,562	1,917	1,743	1,120	810	888	813	1,000	NA
1958	1,856	NA	1,176	NA	907	1,076	993	824	801	NA	984	NA	NA
1975	2,352	1,111	1,359	1,401	1,160	1,356	1,443	1,450	749	1,085	753	1,385	1,300

Average 1360 ppm = (1420 + 1300ppm) / 2

Note: NA means no data avaialble

Source: Data of 1907, 1932 and 1958 are taken from the report of Hydrology of Lake Qarun and other data is collected from the report of Re-Use of Drainage Water for Agricultural Purposes in Fayoum, Dececember, 1981.

Table B4-2 Estimate of Salt Content of Lake Qarun
(Case : A)

Item		Unit	Quant'y	Remarks
Basic Condition				
Annual Mean Water Level	(1)	m	-43.77	refer to Table B3-2
Stored Water Volume in the Lake	(2)	MCM	1,034	refer to Table B3-6
Water Surface Area	(3)	sq.km	238.2	refer to Table B3-5
Salt Concentration	(4)	%	3.8	According to Working Paper of W.Bank
Cumulative Salt Quant'y	(5)	'000 ton	39,300	(2) x (4)
Case A without added water				
Re-use water from Batts drain	(6)	MCM	110	refer to Table B3-4
Re-use water from Wadi drain	(7)	MCM	120	(6) x 5.0 cum/sec / 4.59 cum/sec
Return to the lake	(8)	MCM	48	(7) x 0.4 (irrigation efficiency 60%)
Salt reduced by (6,7)	(9)	'000 ton	322	(110+120 MCM) x 1400 ppm
Stored water reduced by (6,7)	(10)	MCM	855	(2)-(6)-(7)+(8)
Salt added by (8)	(11)	'000 ton	67	(8) x 1400 ppm
Cumulative salt quant'y	(12)	'000 ton	39,045	(5)-(9)+(11)
Salt concentration	(13)	%	4.6	(12) / (10)

Table B4-3 Estimate of Salt Content of Lake Qarun

(Case : A-1)

Item		Unit	Quant'y	Remarks
Basic Condition				
Annual Mean Water Level	(1)	m	-43.77	refer to Table B3-2
Stored Water Volume in the Lake	(2)	MCM	1,034	refer to Table B3-6
Water Surface Area	(3)	sq.km	238.2	refer to Table B3-5
Salt Concentration	(4)	%	3.8	According to Working Paper of W.Bank
Cumulative Salt Quant'y	(5)	'000 ton	39,300	(2) x (4)
Case A-1 with Added Water to Keep Present Water Level				
Re-use water from Batts drain	(6)	MCM	110	refer to Table B3-4
Re-use water from Wadi drain	(7)	MCM	120	(6) x 5.0 cum/sec / 4.59 cum/sec
Return to the lake	(8)	MCM	48	(7) x 0.4 (irrigation efficiency 60%)
Salt reduced by (6,7)	(9)	'000 ton	322	(110+120 MCM) x 1400 ppm
Stored water reduced by (6,7)	(10)	MCM	855	(2)-(6)-(7)+(8)
Water by new resources	(11)	MCM	179	(2)-(10)
Stored water added (11)	(12)	MCM	1,034	(10)+(11)
Salt quant'y added by (8)	(13)	'000 ton	67	(8) x 1400 ppm
Salt quant'y added by (11)	(14)	'000 ton	251	(11) x 1400 ppm
Cumulative salt quant'y	(15)	'000 ton	39,296	(5)-(9)+(13)+(14)
Salt concentration	(16)	%	3.8	(15) / (12)

Table B4-4 Estimate of Salt Content of Lake Qarun

(Case : B)

Item		Unit	Quant'y	Remarks
Basic Condition				
Annual Mean Water Level	(1)	m	-43.77	refer to Table B3-2
Stored Water Volume in the Lake	(2)	MCM	1,034.2	refer to Table B3-6
Water Surface Area	(3)	sq.km	238.2	refer to Table B3-5
Salt Concentration	(4)	%	3.8	According to Working Paper of W.Bank
Cumulative Salt Quant'y	(5)	'000 ton	39,300	(2) x (4)
Case B without added water				
Re-use water from Batts drain	(6)	MCM	110	refer to Table B3-4
Re-use water from Wadi drain	(7)	MCM	120	(6) x 5.0 cum/sec / 4.59 cum/sec
Return to the lake	(8)	MCM	48	(7) x 0.4 (irrigation efficiency 60%)
Salt reduced by (6,7)	(9)	'000 ton	322	(110+120 MCM) x 1400 ppm
Salt added by (8)	(10)	'000 ton	67	(8) x 1400 ppm
Salt reduced by extraction factory	(11)	'000 ton	213	According to report by Nasr Campany
Stored water reduced by (11)	(12)	MCM	6	(11) / 38000 ppm
Stored water reduced by (6,7,8,12)	(13)	MCM	846	(2)-(6)-(7)+(8)-(12)
Cumulative salt quant'y	(14)	'000 ton	38,832	(5)-(9)+(10)-(11)
Salt concentration	(15)	%	4.6	(14) / (13)

Table B4-5 Estimate of Salt Content of Lake Qarun

(Case : B-1)

Item		Unit	Quant'y	Remarks
Basic Condition				
Annual Mean Water Level	(1)	m	-43.77	refer to Table B3-2
Stored Water Volume in the Lake	(2)	MCM	1,034	refer to Table B3-6
Water Surface Area	(3)	sq.km	238.2	refer to Table B3-5
Salt Concentration	(4)	%	3.8	According to Working Paper of W.Bank
Cumulative Salt Quant'y	(5)	'000 ton	39,300	(2) x (4)
Case B-1 with Added Water to Keep Present Water Level				
Re-use water from Batts drain	(6)	MCM	110	refer to Table B3-4
Re-use water from Wadi drain	(7)	MCM	120	(6) x 5.0 cum/sec / 4.59 cum/sec
Return to the lake	(8)	MCM	48	(7) x 0.4 (irrigation efficiency 60%)
Salt reduced by (6,7)	(9)	'000 ton	322	(110+120-48 MCM) x 1400 ppm
Salt added by (8)	(10)	'000 ton	67	(8) x 1400 ppm
Salt reduced by extraction factory	(11)	'000 ton	213	According to report by Nasr Campany
Stored water reduced by (11)	(12)	MCM	6	(11) / 38000 ppm
Stored water reduced by (6,7,8,12)	(13)	MCM	846	(2)-(6)-(7)+(12)
Water added by new water resources	(14)	MCM	188	(2)-(13)
Salt added by (14)	(15)	'000 ton	263	(14) x 1400 ppm
Stored water with (14)	(16)	MCM	1,034	(13)+(14)
Cumulative salt quant'y	(17)	'000 ton	39,095	(5)-(9)+(10)-(11)+(15)
Salt concentration	(18)	%	3.8	(16) / (15)

Table B4-6 Estimate of Salt Content of Lake Qarun

(Case : C)

Item		Unit	Quant'y	Remarks
Basic Condition				
Annual Mean Water Level	(1)	m	-43.77	refer to Table B3-2
Stored Water Volume in the Lake	(2)	MCM	1,034	refer to Table B3-6
Water Surface Area	(3)	sq.km	238.2	refer to Table B3-5
Salt Concentration	(4)	%	3.8	According to Working Paper of W.Bank
Cumulative Salt Quant'y	(5)	'000 ton	39,300	(2) x (4)
Case - C				
Re-use water from Batts drain	(6)	MCM	110	refer to Table B3-4
Re-use water from Wadi drain	(7)	MCM	120	(6) x 5.0 cum/sec / 4.59 cum/sec
Return to the lake	(8)	MCM	48	(7) x 0.4 (irrigation efficiency 60%)
Water interrupted to Rayan	(9)	MCM	176	refer to Table B4-7
Salt reduced by (6,7)	(10)	'000 ton	322	(110+120 MCM) x 1400 ppm
Salt added by (8)	(11)	'000 ton	67	(8) x 1400 ppm
Salt added by (9)	(12)	'000 ton	246	(9) x 1400 ppm
Salt reduced by extraction factory	(13)	'000 ton	213	According to report by Nasr Campany
Stored water reduced by (13)	(14)	MCM	6	(13) / 38000 ppm
- do - by (6,7,8,9,14)	(15)	MCM	1,022	(2)-(6)-(7)+(8)+(9)-(14)
Cumulative salt quant'y	(16)	'000 ton	39,078	(5)-(10)+(11)-(12)-(13)
Salt concentration	(17)	%	3.8	(16) / (15)

Table B4-7 Estimate of Salt Content of Lake Qarun

(Case : D)

Item		Unit	Quant'y	Remarks
Basic Condition				
Annual Mean Water Level	(1)	m	-43.77	refer to Table B3-2
Stored Water Volume in the Lake	(2)	MCM	1,034	refer to Table B3-6
Water Surface Area	(3)	sq.km	238.2	refer to Table B3-5
Salt Concentration	(4)	%	3.8	According to Working Paper of W.Bank
Cumulative Salt Quant'y	(5)	'000 ton	39,300	(2) x (4)
Case D with Rayan water				
Re-use water from Batts drain	(6)	MCM	110	refer to Table B3-4
Re-use water from Wadi drain	(7)	MCM	120	(6) x 5.0 cum/sec / 4.59 cum/sec
Return to the lake	(8)	MCM	48	(7) x 0.4 (irrigation efficiency 60%)
Water interrupted to Rayan	(9)	MCM	176	refer to Table B4-7
Salt reduced by (6,7)	(10)	'000 ton	322	(110+120 MCM) x 1400 ppm
Stored water reduced by (6,7)	(11)	MCM	1,031	(2)-(6)-(7)+(8)
Salt added by (8)	(12)	'000 ton	67	(8) x 1400 ppm
Salt added by (9)	(13)	'000 ton	246	(9) x 1400 ppm
Cumulative salt quant'y	(14)	'000 ton	39,291	(5)-(10)+(12)+(13)
Salt concentration	(15)	%	3.8	(14) / (11)

Table B4-8 Discharges to Wadi El Rayan

(Unit : MCM)

Month	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Mean
January	13.6	1.1	0.6	15.8	3.4	5.4	6.2	4.1	7.4	11.2	6.9
February	1.1	1.7	4.1	1.4	5.6	14.3	5.8	12.9	6.6	12.7	6.6
March	15.8	12.4	14.6	7.0	15.8	15.8	15.8	22.0	11.2	23.1	15.4
April	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.0	10.8	22.6	15.6
May	15.8	15.8	15.8	15.8	15.8	15.8	15.8	20.6	18.4	23.2	17.3
June	15.3	15.3	10.5	12.0	15.3	15.3	15.3	13.2	22.0	22.2	15.6
July	15.8	15.8	2.5	12.4	10.9	15.8	23.3	9.6	24.0	23.2	15.3
August	15.8	15.8	15.8	12.4	13.6	15.8	23.3	9.6	23.0	23.3	16.8
September	15.3	15.3	15.3	15.3	15.3	15.3	22.5	9.3	22.0	22.6	16.8
October	15.8	15.8	15.8	15.8	15.8	15.8	23.3	12.5	22.0	23.2	17.6
November	15.3	15.3	15.3	15.3	15.3	15.3	4.2	9.3	22.3	22.4	15.0
December	15.8	15.8	15.8	15.8	15.8	15.8	23.3	9.6	23.0	23.5	17.4
Total	170.7	155.4	141.4	154.3	157.9	175.7	194.1	147.7	212.7	253.2	176.3

Source: M.O.I., Fayoum.

B-5. Other Water Demand

Nile water is used not only for irrigation purposes but also a domestic water supply in Fayoum depression. The small amount of water of about 34 MCM is supplied for domestic water system of the Fayoum area, which amount is only 1.5 percent of the total supplied water to the Fayoum area.

The annual increase rate of potable water is calculated at five percent per annum which is bigger than that of population increase rate of 2.8 percent.

On the other hand, water supply per capita is calculated at about 60 lit/day. During the past three years this rate is almost same. (refer to Table B5-1)

Table B5-1. Domestic Water Supply (for Fayoum Governorate)

(Unit:cu.m)

Month	1977	1978	1979	1980	1981	1982	1983	Mean
Jan.	2,066,336	1,976,356	2,503,100	2,690,376	2,635,628	2,706,488	2,815,632	2,484,845
Feb.	1,816,480	1,801,844	2,430,864	2,509,740	2,513,032	2,492,840	2,498,176	1,947,445
Mar.	2,037,320	1,893,616	2,698,276	2,714,200	2,714,820	2,834,240	2,779,784	2,524,608
Apr.	2,052,852	1,903,383	2,602,898	2,633,736	2,645,460	2,709,812	2,669,948	2,459,727
May	2,170,402	2,075,292	2,641,900	2,749,044	2,821,644	2,841,364	2,833,896	2,590,506
Jun.	2,125,807	2,239,878	2,574,482	2,637,522	2,844,872	2,911,630	2,910,228	2,606,346
Jul.	2,265,932	2,702,628	2,731,824	2,906,892	2,957,112	3,061,504	3,070,246	2,813,734
Aug.	2,252,538	2,862,672	2,804,184	2,773,828	2,985,298	3,097,440	3,023,494	2,828,493
Sept.	2,192,796	2,737,440	2,690,288	2,810,124	2,797,173	2,957,388	2,840,756	2,717,995
Oct.	2,198,316	2,762,748	2,781,252	2,830,508	2,934,200	2,983,608	2,988,360	2,782,713
Nov.	2,014,757	2,584,964	2,643,804	2,602,980	2,744,430	2,784,564	2,850,300	2,603,686
Dec.	2,031,454	2,516,676	2,714,184	2,684,520	2,706,488	2,962,458	2,942,856	2,651,234
Total	25,224,990	28,057,497	31,817,056	32,543,470	33,300,157	34,343,336	34,223,676	33,535,940
Mean	2,102,083	2,338,125	2,651,421	2,711,956	2,775,013	2,861,945	2,851,973	2,794,662
Population (x1000)	1,369	1,377	1,385	1,493	1,532	1,571	1,600*	1,475
per person (lit/day/person)	50.48	55.82	62.94	59.56	59.55	59.89	58.60	62.29

Note: The figure with * mark is a estimated number.
Source: Fayoum Potable Water Supply

APPENDIX C.

SOIL

APPENDIX C. SOIL

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APPENDIX C. SOIL

C-1. General Geology

The Fayoum depression itself is excavated in Middle Eocene rocks, which form the oldest exposed beds in the area, composed essentially of Gypseous shales, white marls, limestone and sand (known as ravine beds).

The southern and western parts of the Fayoum area consists of white limestone, agrillaceous sand and sandy shales (known as Wadi El Rayan formation).

The Northern terraces overlooking Fayoum depression are essentially of Upper Eocen beds composed of shales and limestone in the lower beds with sand and sandstone in the upper beds (known as Qaar El Sagha formation).

The Upper Eocene beds are followed by Oligeous beds which are mainly composed of fluvio-marine variegated sands and sandstone with alternating beds of shallow marls and calcareous grits containing silicified wood (known as Qatrani formation). Above the Qatrani formation there is the basalt intrusions fissured as a sheet of constant horizon (20 to 25 m thick).

Lower Miocene rocks are found in the northwestern parts of the area. These beds are composed essentially of sands, gravels, silicified tree trunks and unfossilferous sandstone quartizite (known as Gabel El Khashab beds).

The pleistocene deposits, mainly of fluvio-lacustrine origin, constitute the subsurface of the Fayoum depression between the recent Holocene deposits.

C-2. Soil

C-2.1. North Wahby and Com Osheem Areas

(1) Soil Survey Works

A semi detailed soil survey in the Project Area was already carried out to select suitable lands for reclamation in 1961. Soil survey for the Project was carried out with reference to the result of the former survey works.

A total of 65 boreholes in both areas have been staked out as shown in the soil classification maps. The distance between the holes was taken as 1,000 m (i.e. each hole represents 240 feddan). The depth of the holes was taken as 2.0 m where soil permitted easy augering. However, augering was discontinued when hard pans were encountered.

Thus, the program of soil survey in this study was greatly referenced to that Egyptian Report (Re-use of Drainage Water for Agricultural Purposes Fayoum: By Dr. Dia El Din El Quesy, and Dr. Samia El Cuindi, December 1961, Drainage research Institute, Water Research Center, Ministry of Irrigation, Egypt).

1) Preliminary Survey

The soil survey works started with the preliminary survey by field reconnaissance in order to grasp the general conditions of the survey area. During the preliminary survey, the landscape within the survey area, that is, topography, relief, land use, and existing road networks were carefully investigated.

2) Soil Profile Survey

In order to execute the profile survey, the existing soil map, that is, soil classification map of scale 1:25,000 which was prepared by the Ministry of Irrigation in 1981 was used to select the representative sites of soils.

Soil profile survey in the representative sites was examined to a depth of approximately 100 centimeters where soil permitted easy digging. When hard pan or unweathered rock was encountered, digging was discontinued.

The total of 66 sites was selected for open pits and supplementary survey with small auger.

The morphological features of the soil profiles were carefully observed and described. These features are soil color, texture, gravel and stone, humus, structure, consistency, wetness, mottling, concretion, crust, spot, parent rocks, accumulations of salt, calcium carbonate and gypsum, and layer boundaries.

3) Soil Sampling

Soil samples for the chemical and physical analysis, pH and EC measurement were taken from two, three or four layers in each soil profile of open pits which were dug at the representative sites.

There were 60 soil samples selected for chemical and physical analysis from 21 soil profiles. Besides these soil sample, 108 soil samples for pH and EC measurements were taken from the top-layer nd sub-layer of profiles at 45 sites.

The chemical and physical analysis for the above-mentioned soil samples collected from the survey areas were carried out in the laboratory of Agriculture, Cairo University at Fayoum.

4) Results of Soil Analysis

The Result is shown as Table C-2.1.

(2) Soil Classification

The Project Area is located in an arid region where annual average rainfall, evaporation and temperature, are 9 mm, 3,000 mm and 22°C, respectively. Soil profiles were classified according to Soil Taxonomy.

1) Aridisols

Aridisols are mineral soils that have an ochric and anthropic epipedon and a salic horizon within 75 cm of the surface and thermic temperature region. These soils can be considered to belong to the Order, Aridisols, suborder orthids, great group Salorthids, subgroup Typic Salorthids and up to the family level.

Typic Salorthids

* Sandy, thermic soils with moderately deep hard pan; EBA-S-mp
* Sandy loam over sandy clay loam, thermic soils with moderately deep hard pan; EBA-SL/SCL-mp
* Sandy, thermic soils with deep zone; EBA-S-D_2
* Sandy clay, thermic soils with deep hard pan; EBA-SC-D_2P

2) Entisols

Entisols are mineral soils that have an ochric and an anthropic epipedon and do not have a diagnostic horizon. These soils have below the Ap horizon or a depth of 25 cm, whichever is deeper, 35 percent (by volume) of rock fragments that have a texture of loamy fine sand or coarser in all subhorizons either to a depth of one meter to a lithic paralithic, or petroferric contact, whichever is shallower. These soils have torric moisture regime. Thus, these soils can be considered to belong to the Order Entisols, suborder Psaments, great group Toripsamments, subgroup Typic Toripsamments and up to family level.

Typic Torripsamments

* Sandy, thermic soils with moderately hard pan; JCB-S-mp
* Sandy over sandy clay, thermic soils with moderately deep hard pan; JCB-S/SC-mp
* Sandy, thermic soils with deep zone; JCB-S-D_2
* Sandy clayey, thermic soils with moderately deep hard pan; JCB-SC-mp
* Sandy over sandy clay loam, thermic soils with shallow hard pan; JCB-S/SCL-sp

(3) Explanation of Soil Profile

* Sandy, thermic soils with moderately deep hard pan (EBA-S-mp)

Included Profiles	:	open pits (3, 16)
Location	:	Com Osheem Area (3), North Wahby Area (16)
Hard Pan	:	50 cm, calcic sand stone (3) 45 cm, limestone
Profile	:	Soil Profile CN-16 in Fig. C2-1
Surface	:	dull yellow orange color, sandy texture
Subsoil	:	light yellow orange color, sandy texture

Hard pan can be easily broken by agricultural machine.

* Sandy loam over sandy clay loam, thermic soils with moderately deep hard pan (EBA-SL/SCL-mp)

Included Profiles:		open pits (4, 8, 13, 21)
Location	:	Com Osheem area (4) North Wahby Area (8, 13, 21)
Hard Pan	:	65 cm calcic sand stone (4) 65 cm shale (8) 80 cm shale (13) 80 cm calcic sand stone, shale (21)
Profile	:	Soil Profile CN-4 in Fig. C2-1
Surface	:	dull yellow orange color, sandy loam texture
Subsoil	:	light yellowish brown color, sandy clay loam texture

* Sandy, thermic soils with deep zone (EBA-S-D_2)

Included Profiles:		open pits (5, 15)
Location	:	North Wahby area (15) Com Osheem area (5)
Profile	:	Soil Profile CN-5 in Fig. C2-1
Surface	:	light yellow color, sandy clay loam or sand clay texture
Subsoil	:	Light gray to yellowish brown color, sand texture

* Sandy clayey, thermic soils with deep hard pan (EBA-SC-D_2P)

Included Profiles:		open pits (6, 18)
Location	:	North Wahby Area (18, Com Osheem Area (6)
Hard Pan	:	90 cm, shale (6) 100 cm, calcic sand stone (18)
Profile	:	Soil Profile CN-6 in Fig. C2-1
Surface	:	yellow orange color, sandy clay texture
Subsoil	:	dull yellow orange color, clayey texture

Shale or calcic sand stone can be easily soften by adding water or by using agricultural machines.

* Sandy, thermic soils with moderately hard pan (JCB-S-mp)

Included Profiles	:	open pits (1, 7, 10)
Location	:	North Wahby area (7, 10), Com Osheem area (1)
Hard Pan	:	65 cm, calcic sandstone (1) 90 cm, taff (7) 65 cm, taff (or shale) (10)
Profile	:	Soil Profile CN-1 in Fig. C2-1
Surface	:	dull yellow orange color, sandy structure
Subsoil	:	light yellow orange color, loamy sand textures

Hard pan, mainly consist of calcic sandstone which can be easily broken by agricultural machine.

These soils are salinity soils. Cation and water holding capacity of their soils are weak. And contents of organic carbon and available phosphorus are low. Thus, their soils have poor fertility. But leaching the salt from the surface is not difficult on account of their good permeability.

* Sandy over sandy clay, thermic soils with moderately deep hard pan (JCB-S/SC-mp)

Included Profiles	:	open pits (11, 12, 14)
Location	:	North Wahby area (11, 12, 14)
Hard Pan	:	70 cm (similar to taff) (11) 70 cm (shale) (12) 70 cm (shale) (14)
Profile	:	Soil Profile CN-12 in Fig. C2-1
Surface	:	dull yellow orange color, sandy structure
Subsoil	:	light gray color, sandy loam to sandy clay loam texture

Hard pan can be easily become to soft by adding water.

* Sandy, thermic soils with deep zone (JCB-S-D_2)

Included Profiles: open pits (9, 19, 20)

Location : North Wahby area (9, 19, 20)

Profile : Soil Profile CN-19 in Fig. C2-1

Surface : dull yellow orange color, sandy structure

Subsoil : light gray color, sandy structure, water table can not be found at a depth of 130 cm and more

* Sandy clayey, thermic soils with moderately deep hard pan (JCB-SC-mp)

Included Profiles: open pits (17)

Location : North Wahby area (17)

Hard Pan : 35 cm, calcic sandstone and shale

Profile : Soil Profile CN-17 in Fig. C2-1

Surface : dull yellow orange color clayey texture

Subsoil : Grayish yellow brown color, sandy clay to sandy clay loam texture

* Sandy over sandy clay loam, thermic soils with shallow hard pan (JSB-S/SCL-sp)

Included Profiles: Open pits (2)

Location : Com Osheem Area (2)

Hard Pan : 35 cm, shale, calcic sandstone

Profile : Soil Profile CN-2 in Fig. C2-1

Surface : dull yellow orange color, sandy texture

Subsoil : light yellow orange color, sandy clay loam texture

Hard Pan can be easily broken by adding water or agricultural machine.

(4) Soil Salinity

In general, the soils in the Project Area have high salinity, ranging from two to 370 mmhos/cm. (refer to Table C2-1) Thus, the salinity land type can be classfied as follows:

Type	Surface/Sub Surface	EC(mmhos/cm)
1	Salt free to weakly saline/weakly saline	less than 4/ less than 4
2	weakly saline to moderately saline/weakly saline	4.1 to 8/ more than 4
3	moderately saline to strongly saline/moderately saline	8.1 to 15.1 more than 8.1
4	strongly saline/strongly saline	more than 15.1/ more than 15.1

The salinity maps were presented as attached in this volume.

(5) Soil Improvement

In order to improve the soils for the agricultural use, the following works must be planned.

1) Lipping (Deep Harrowing)

Hard pan consists of calcic sandstone, taff, shale and mineral colloidal materials. Calcic sandstone can be easily broken by agricultural machine. And taff, shale and colloidal materials can be easily softened by adding water.

2) Leaching

Leaching the salt from the soils is very important, because the land has a very high salinity.
(refer to soil salinity map)

In general, gypsum application is necessary before leaching with reference to Indian Report (I.P. Abrol and D.R. Bhumbla; Leaching Salt Soils, April 1972, Indian Farming). In this report, the main object of gypsum application is to make well permeable in the soil profiles and decrease the toxic Na ion for plant growth in the soils.

Most of the surface soils in the Project Area are sandy to sandy loam texture nd contain a high percentage of soluble calcium and magnesium. Primary leaching should be carried out by irrigation water.

3) Gypsum Requirement

The data of Gypsum requirement are not included in the attached results of soils analysis. With regard to the reference[1/], Gypsum requirements can be obtained as following procedure.

a. Reagent[2/]

Approximately saturated gypsum solution of known calcium concentration. Place about five grams of $CaSO_4 \cdot 2H_2O$ and one liter of water in a flask, stopper, and shake by hand several times during a period of one hour or for 10 minutes. In a mechanical shaker. Filter and determine the calcium concentration of a 5-ml. aliquot of the solution. The calcium concentration should be at least 28 meq./lit.

Note:

1/ United States Salinity Laboratory Stuff, Diagnosis and Improvement of Saline and Alkali Soils of United State of Agriculture, 1969.

2/ Schoonover, W.R. Examination of Soils for Alkali. University of California Extension Service, Berkeley, California, 1951.

b. Procedure

Weight five grams of air-dried soil into a 4-oz. bottle. Add 100 ml. of reagent A by means of a pipet. Stopper the bottle and shake by hand several times during a period of 30 min. or for five min. in a mechanical shaker. Filter part of the suspension and determine the calcium plus magnesium concentration of a suitable volume of the clear filtrate.

c. Calculations

Gypsum requirement, meq./100 gm. = (Ca conc. of added gypsum solution in meq./lit. - Ca + Mg conc. of filtrate in meq./lit.) x 2

On the other hand, following report can be referenced with regard to the desired reduction of exchangeable sodium percentage.

d. Estimation of Amounts of Various Amendments Needed for Exchangeable Sodium Replacement

Exchangeable sodium and cation-exchange-capacity determinations serve as valuable guides for estimating the amounts of chemical amendments needed to reduce the exchangeable-sodium-percentages of alkali soils to given levels. The procedure for estimating the amount of amendment needed for a given set of conditions can be illustrated by an example. Suppose the 0 to 12-in layer of an alkali soil contains 4 meq. of exchangeable sodium per 100 gm. and has a cation-exchange-capacity of 10 meq. per 100 grams. The exchangeable-sodium-percentage is therefore 40. It is reduce the exchangeable-sodium-percentage to about 10). This will necessitate the replacement of 3 meq. of exchangeable sodium per 100 grams. Assuming quantitative replacement, it will be necessary to apply the amendment at the rate of 3 meq. per 100 grams. of soil.

However, following formula on the Gypsum Requirement was obtained by GARPAD's comment. (1984, April, in Japan)

- Calculate Exchangeable Na% = $\frac{\text{Exchangeable Na x 100}}{\text{Cation Exchange Capacity (CEC)}}$
  if value is more than 15%, hence soil is alkali.
- Calculate 15% of Cation Exch. Capacity
  $= \frac{\text{CEC x 15}}{100} = \text{A meq./100 gm.}$
- Exchangeable Na^+ meq./100 gm. = B
- Excess exchangeable Na^+ over 15%, which should be removed
  = B - A = C
- Gypsum needed = C x 1.72 x ton/feddan
- Amount of Gypsum in soil to depth of 30 cm
  = Gypsum in soil meq./100 g x 1.6 = Y ton/feddan
- Gypsum that must be added = X - Y ton/feddan

According to the GARPAD's comment, gypsum requirements in the Project Area were estimated as shown in Table C2-2 under the condition of without Gypsum Present.

4) Clayey Soil Dressing

In general, surface soils in the Project Area have gravelly to sand texture. And these soils have low water holding capacity and poor base exchange capacity. Thus, clayey soil dressing is recommended to be applied to the surface soils in the Project Area.

So-called "manure" from the canals is one of the best source to dress the land surface.

5) Application of Organic Matter

The amount of organic matter contained in the soils of the Project Area is 0.3 percent on an average, this is considered to be extremely small. Content of N and P in the soils was also found to be limited. Moreover, they are sandy and saline soils. The application of organic matter in such soils will create the following essential improvements.

- enhancement of air permeability, water retentivity and fertilizer retentivity
- control of soil consolidated caused by salt
- create a source of supply of chemical substances especially N
- create a buffer action against salinity

From the viewpoint of the soils in the Project Area, application of organic matter will be important in realizing stable crop production. Manure and clover can be used as raw materials for creating the necessary amounts of organic matter. Since decomposition of organic materials is faster in arid zone soils than in humid zone soils, frequent application of organic matter will be required. The desirable amount of organic matter to be applied is ten tons/ha (4.2 tons/feddan) or more, the lowest amount, which is acceptable is two to three tons.

6) Land Capability Classification

a. Present Soil Condition

The result of soil survey and analysis are summarized as follows;

- The texture of the soil in North Wahby and Com Osheem areas is defined as mostly sandy and a little sandy clay loam.

- The EC value ranges from two to 200 mmhos/cm, and half of them are more than 15 mmhos/cm.

- The percentage of organic carbon and nitrogen in the area are generally very low.

- Hard pan which is consisted of calcic sand stone, shale, taff and mineral colloid are observed at depths of

0 - 30 cm	Shallow hard pan
30 - 60 cm	Moderately deep hard pan
60 - 90 cm	Deep hard pan
more than 90 cm	"

b. Soil Improvement

As mentioned above, the present soil condition in the area is not suited to agriculture. Therefore, some soil improvements as described in the paragraphs of 1) - 5), shall be carried out.

c. Land Capability Classification

After finishing the land reclamation and soil improvement mentioned before, the land in the area can be classified according to the following categories.

I.	Excellent, no limitation for agricultural use
II.	Good, no important limitations for agricultural use
III.	Fairly good, some limitations for agricultural use
IV.	Low value, strong limitations for agricultural use
IV/V.	Very low value, very strong limitations for agricultural use
V.	Limited arable: not suitable for agricultural use