THE ARAB REPUBLIC OF EGYPT

MINISTRY OF IRRIGATION

FINAL REPORT

ON

FEASIBILITY STUDY

FOR

THE SOUTH HOSAINIA VALLEY AGRICULTURAL DEVELOPMENT PROJECT

(ANNEXES)

VOLUME 2

MARCH 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

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JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL PLANNING MAP

LEGEND

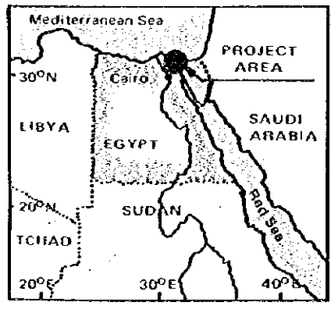
- DIVERSION FACILITY
- IRRIGATION CANAL
- DRAINAGE CANAL
- FEEDER ROAD
- VILLAGE ROAD
- SMALL VILLAGE
- SERVICE VILLAGE
- CENTRAL VILLAGE
- (P) PUMPING STATION FOR DRAINAGE
- (Pi)(Pi) PUMPING STATION FOR IRRIGATION
- LIVE-STOCK CENTER

Bahr Saft drain

El Salam canal

Bahr Bagar drain

KEY MAP



SCALE

0 1 2 3 4 5 Kilometres

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ABBREVIATIONS AND GLOSSARY

ARE	:	Arab Republic of Egypt
B/C	:	Benefit Cost Ratio
CIF	:	Cost, Insurance and Freight
EIRR	:	Economic Internal Rate of Return
ET	:	Evapotranspiration
FAO	:	Food and Agriculture Organization
FC	:	Foreign Currency
FOB	:	Free on Board
FY	:	Fiscal Year (July 1st to June 30th)
IBRD	:	International Bank of Reconstruction and Development
JICA	:	Japan International Cooperation Agency
K	:	Potassium
LC	:	Local Currency
LE	:	Egyptian Pound = 1.4 US$ = 300 Japanese Yen
MOA	:	Ministry of Agriculture
MOI	:	Ministry of Irrigation
MOLR	:	Ministry of Land Reclamation
N	:	Nitrogen
O & M	:	Operation and Maintenance
P	:	Phosphorous
$, US$	:	Dollar, US$ = 0.74 LE

Units of Measurement

Length

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer

Area

sq.cm, cm^2	:	square centimeter
sq.m, m^2	:	square meter
sq.km, km^2	:	square kilometer
MSM, $10^6 m^2$	:	million square meter

Volume

ℓ, lit	:	liter
cu.m, m^3	:	cubic meter
MCM, $10^6 m^3$	:	million cubic meter

Weight

g	:	gram
kg	:	kilogram
ton, m.t.	:	metric ton

Others

EL	:	elevation above mean sea level
MSL	:	mean sea level
FWL	:	full water level
HWL	:	high water level
LWL	:	low water level
sec	:	second
minu	:	minute
hr, hrs	:	hour or hours
min	:	minimum
max	:	maximum
%	:	percent
PPM	:	part per million
No.	:	Number
°C	:	degree centigrade
°F	:	degree fahrenheit
Cl	:	Chlorine
HP, PS	:	Horse Power
lit/sec	:	liter per second
m/s	:	meter per second

Conversion Factors

Unit	Comparison
Units of Length	
Millimeter (mm)	0.001 meter
Centimeter (cm)	0.01 meter
Meter (m)	100 cm
Kilometer (km)	1,000 meters
Units of Area	
Square centimeter (sq.cm)	0.0001 sq.m
Square meter (sq.m)	
Hectare (ha)	10,000 sq.m
Square kilometer (sq.km)	1,000,000 sq.m
Feddan	4,200 sq.m
Units of Volume	
Cubic centimer (cu.m)	0.001 cu.m
Liter (1,000 cu.m)	0.001 cu.m
Cubic meter (cu.m)	1,000 liters
Units of Weight	
Gram (g)	
Kilogram (kg)	1,000 g
Metric Ton (mt)	1,000 kg

Miscellaneous

1 cu.m per sec	=	1,000 liters per second (ℓ/s)
	=	35.3145 cu.ft per second (cfs)
	=	15,850 gallons per minute (gpm)
1 liter per second for 1 day	=	8.64 mm depth over one hectare
10 mm depth over 1 hectare	=	1.157 liters per second for 1 day
	=	3,532 cu.ft
1 horsepower (metric)	=	75 kg-m per second
	=	550 ft-lb per second
1 cu.m per day per feddan	=	0.238 mm/day = 2.38 ℓ/day/ha

C-1. INTRODUCTION

Reclamation of the waste lands for increasing agricultural production under reasonable supply of irrigation water would be a very fundamental prerequisite for successful contribution to national food security.

Aiming at a maximum possible exploitation of the lands along the Suez Canal Region, the El Salam Canal Agricultural Project has been planned involving construction of main canal, irrigation and drainage facilities, land reclamation and soil improvement, followed by farm village settlements. The South Hosainia Valley Agricultural Development Project was set up as the first area to be implemented and its feasibility study was performed from August to November, 1980.

During the study term Soil Survey was carried out on the profile examination, soil characteristics, distribution and classification into Soil Types. These types were evaluated of Land Classes for land reclamation and soil productivity using physical and chemical analysis data of the soil and groundwater samples taken from the field.

Because of the high saline alkali soils of Solonchaks prevailing all over the Area, special concerns were paid to investigate the status of salinity and process of leaching.

The survey was limited to the uncultivated flat land of recent alluvial deposits forming north-easterly part of the Nile River Delta. The surveyed area amounted in total to 31,400 ha. Separate soil map and land class maps for irrigated agriculture were compiled at a scale of 1:50,000, respectively.

The study team owes a debt of gratitude both to the staff of the Ministry of Irrigation and Ministry of Land Reclamation for their helpful cooperation in the field investigations and laboratory analyses.

C-2. GENERAL DESCRIPTION OF AREA

C-2-1. Location and Topography

1) Location and Area

The Project Area is situated in the most north-eastern part of the Nile River Delta of the ARAB REPUBLIC of EGYPT, in the north latitude, 30° 54' to 31° 6' and east longitude, 31° 52' to 32° 13', about 115 km north east of Cairo, and its local administration belongs to the Sharkia Governorate (see Fig. C-2-1).

The Area is almost uncultivated soil desert, adjoining San El Hagar City on the west, the Manzala Lake on the north which is a big coast lagoonal lake facing the Mediterranean Sea, and the Suez Canal Area on the east by a short distance of 10 km, and on the south being separated from El Sharkia desert area by Bahr El Baqar Drain. This Drain runs along the south-easterly limit of the Area to the north, meeting at right angles with the planned line of El Salam Canal. Bahr El Saft and Hadous Drain also mark the north-westerly limit up to the junction with the Canal Line. The south-westerly border is drawn zigzag from San El Hagar down to Bahr El Baqar Drain, excluding some settlement farm lands. Ramses Drain passes through the Area from San El Hagar toward east to the Canal Line.

The total extent is 31,400 ha (74,700 feddan) with a subtraction of area which will be occupied by the Canal stream.

2) Topography of the Area

Topography of the Area is very simple and flat, displaying a soil desert feature. Only El Hosainia Hill, the adjacent land, stretches out on the south-western part of the Area, making somewhat an undulating feature on the central flat parts where many low clay dunes are seen. Several mountainous hills which are called "Tell" around 20 m high and mostly ancient ruin sites are located from west to east in the Area. These served as a good mark to confirm situations of the surveyed sites.

Most of the other area are flat and very gently slope toward Manzala Lake. This valley consists of alluvial clay materials transported by the River Nile and has an extremely saline top layer which is slightly covered with wind blown deposits of rather fine texture. These lands lie at elavations of between sea level and about 2 m. Therefore, about one-third of the lands are swampy and covered with water throughout the year or frequently flooded with the seasonal increase of the Drain water. Many fish-raising ponds spread along the Drains from which fishermen are always taking water by pumping.

3) Division of Land by Slopes

Since most of the land slopes are less than 2% (flat or almost flat), further subdivision by 0.1% grade was attempted of every patch of the land. Slope was measured of the density in contour lines on the 1:10,000 scaled Topographical Maps which have been newly drawn by the Topography Survey Team in the present study.

Table C-2-1 is the result obtained as divided in three area groups for convenience and Fig. C-2-2 shows the areal distribution. As is clear from the data, 90% of the Area distribute within 0.3% slope which would cause no trouble with general land use for agriculture. For irrigated agriculture, however, close investigation will be necessary to make a suitable design of canal and drain arrangements specifically in this Area.

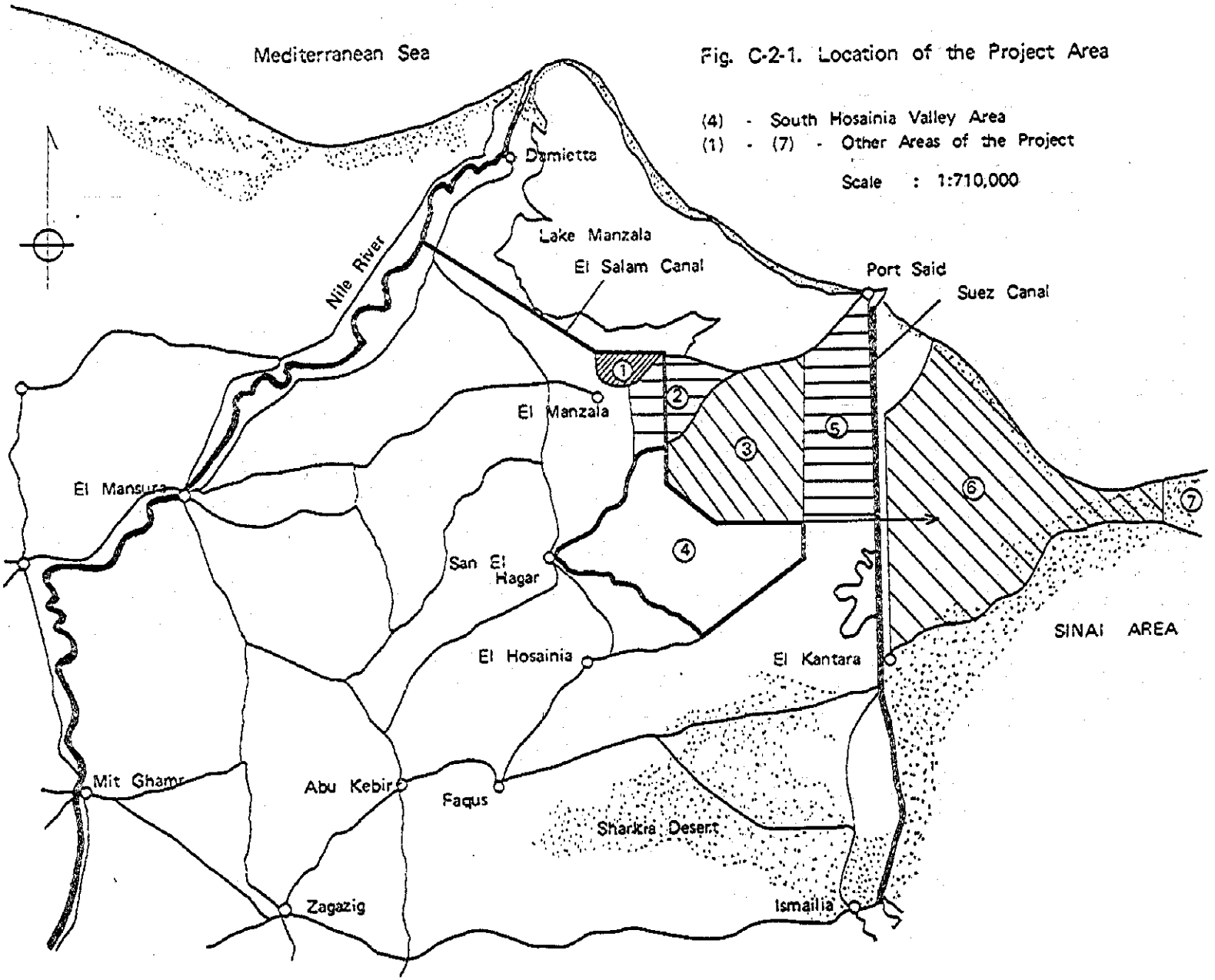


Fig. C-2-1. Location of the Project Area

(4) - South Hosainia Valley Area
(1) - (7) - Other Areas of the Project

Scale : 1:710,000

Table C-2-1. Distribution of Area by Slopes

Slope %	Dibgu Area ha	Sanhur Area ha	Biluim Area ha	Total ha	feddan	%
< 0.1	4,790	2,710	4,440	11,940	(28,400)	38.0
0.1 - 0.2	1,170	2,420	2,560	6,150	(14,630)	19.6
0.2 - 0.3	2,440	5,240	2,510	10,190	(24,250)	32.5
0.3 - 0.5	350	1,555	490	2,395	(5,700)	7.6
0.5 - 1.0	30	530	0	560	(1,330)	1.8
> 1.0	10	35	120	165	(390)	0.5
Total	8,790	12,490	10,120	31,400	(74,700)	100
feddan	20,900	29,710	24,090	74,700	-	-

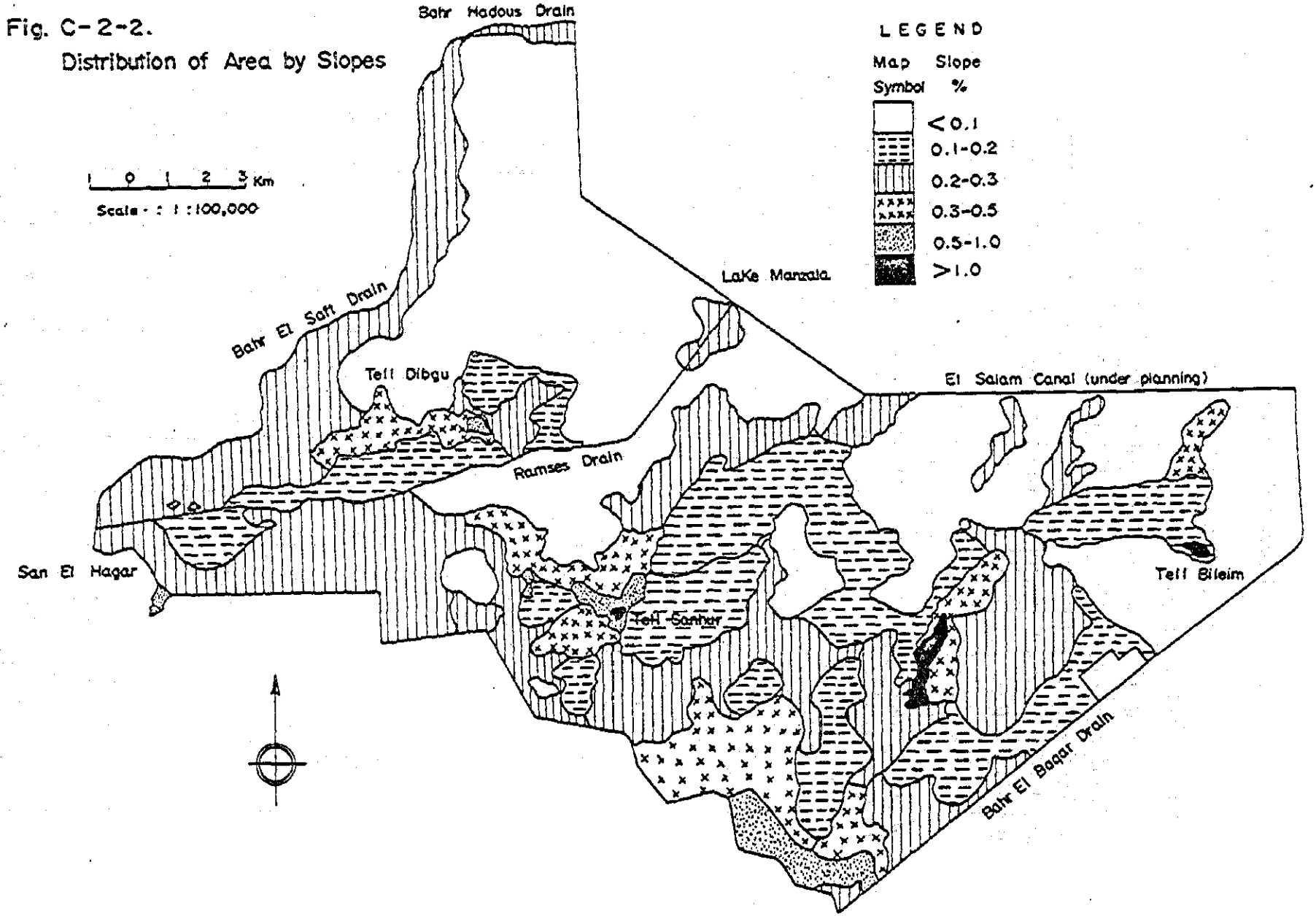
Remarks: Three areas are divided as follows;

Dibgu Area - North of Ramses Drain

Sanhur Area - Between Ramses Drain and a tentative line from the turning point of El Salam Canal to the southern end of the Area.

Biluim Area - East of the above line.

Fig. C-2-2.
Distribution of Area by Slopes



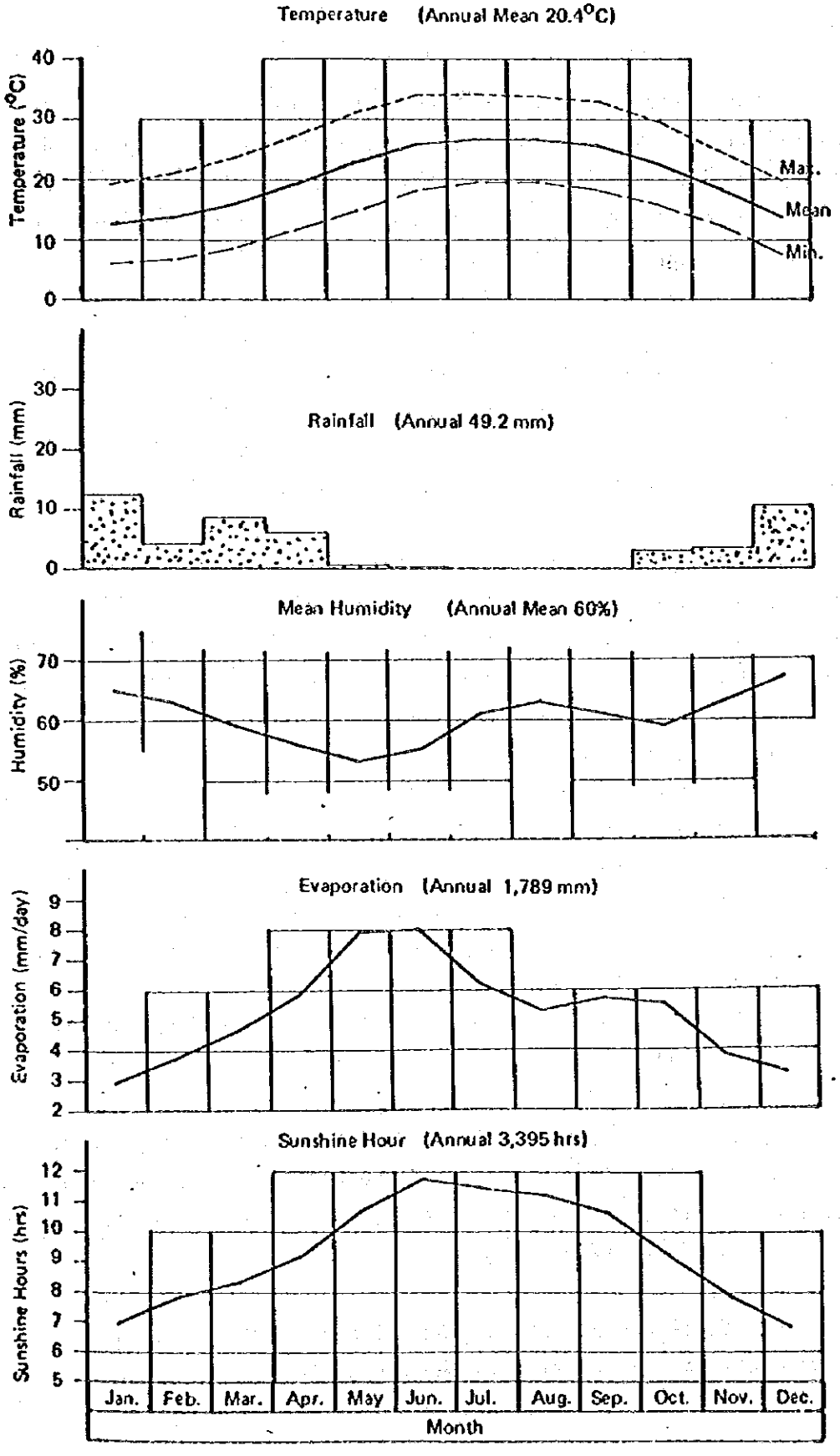
C-2-2. Climate

The climate in the Project Area is almost similar to that of the Mediterranean coastal zone. The summers are dry but not too hot due to the coast tempering effect on the summer heat. The winters are rather cool and wet, when rainfall centers amounting to more than half of the annual total.

Since there are no available climatic data for the Project Area, those obtained by the adjacent meteorological observatory at El Mansura are shown in Fig. C-2-3. The evapotranspiration is so great as 5.3 mm/day and 1,920 mm/year on the average, resulting in the remarkable salt accumulation on soil surface in the Area.

ANNEX B compiles necessary meteorological data.

Fig. C-2-3 Meteorological Conditions



Station: El Mansoura, Observation Period: 1969 to 1978

C-2-3. Geology

The geology of the Project Area is characterized by fluvio-marine alluvium deposits of fine texture which were transported by the River Nile. The alluvium deposits are of recent origin and very deep. The depth of these clayey deposits is not so clear within the Area, but in north-west of Bahr El Baqar Drain it has been observed that they are overlying a medium textured substratum. Most of the profile are composed of several heavy or lighter textured layers, suggesting the past history of big floods caused by the River Nile. Therefore, profile development is very low except for gley and mottling phenomena. The soil thus became Solonchaks through the quaternary lagoonal and lacustrine processes of soil formation.

Silting up is considered still in progress in Lake Manzala, but probably at much lower rate than in the past since the lake is now almost separated from the intrusion of sea water. As a result, the Area itself seems to become more dry particularly after the construction of the Aswan High Dam.

Matrix, that is, origin of soil materials depends on the geological strata of upper stream of the Nile. The strata, sandstones partly inserted with limestones and granites, had been transported through a long weathering process to form the Nile Delta. (22) The borehole data on geotechnical properties of the soil obtained at Pump Station that is planned to be situated on the northern starting point into the Project Area informs outline of the deep substratum sequence as follows: (21)

Texture is composed of clay and silt mixed with organic clay down to about 13 m from the surface and beneath that, sand and gravel materials follow. Groundwater there contains total dissolved salts (TDS) of 13,000 to 17,000 ppm.

The situations of such geological profile may be similar to the above-mentioned observation in the Project Area.

Other physiographical descriptions will be referred to in each of the survey results which will be reported in this ANNEX.

C-2-4. Agriculture

Since the Project is aiming to reclaim new farm land, there is no active agriculture at present in the Area except for some fishery which has been carried by people nearby living. They are breeding small fishes which are hatched in the local government's pond. The fishes are called "Toubara or Bouri" (official name), a kind of gray mullet. They grow very fast up to 30 cm in one year without any food. People catch them in the last months, from October to November by pumping out the pond water and send to adjacent markets.

In the same season, a few people start to hunt eagles on the low flat area. The bird comes from South Europe only in this season and big one is dealt with at a very high price.

For detailed informations on the agriculture status surrounding the Area and the future development programs, ANNEX D can be referred to.

C-3. FIELD INVESTIGATION AND TEST

C-3-1. Field Soil Survey

The survey was conducted in cooperation with the staff of Ministry of Land Reclamation and Ministry of Irrigation between the end of August and the end of October, 1980.

1) Soil Profile Survey

Using topographical maps (scale 1:25,000-1950), pit survey was scheduled to be done at a rate of one pit per 300 ha (700 feddan) within the accessible parts of the Area because of the limited survey term. Even in these parts a long time walk to reach the sites was forced with the frequent use of ferry or fishing farmer boats.

Around one third of the whole area was inaccessible due to the water-logged conditions near Lake Manzala where it is shallow but very broad without any traffic facilities. Only one two-wheel drive vehicle was available for this survey. It took more than three hours every day to travel between San El Hagar and the site, occasionally causing troubles by getting stuck because of few available unrepaired wetland roads. Each pit was dug to the depth of 100 to 120 cm and the profile was examined, so far as the ground water was not reached. When it came out, a hand auger (post-hole type) was used for further survey of the lower layers.

Three pit surveys were maximum in one day, starting at six o'clock in the morning and having to be stopped early in the afternoon when north-eastern wind from the sea caused sand pillars here and there, which made it impossible to continue the survey. Because the landscape has no distinct mark on the central plain except for one or two Tells if any and few white sails of the boats passing the Drain in the distance, some red flags stood up by the Topography Survey Team on measuring line points were very helpful to ascertain the site situation.

Consequently, 58 pits were dug during the term. Their location are shown in a seperate map (see MAP C-1), and brief explanations of geography for the pit sites are given in Table C-3-1.

Table C-3-1 Brief Geography of Soil Pits

Soil Series	Soil Type	Pit No.	Location	Elevation m	Depth of groundwater cm
Clay Swamp	Ms 1	34+	Machamad Mahach, 3.5 km south of Hadous D.	0.2	36
"	Ms 2	31+	El Mahish, 2 km south-east of Saft Drain	0.3	55*
"	"	36	El Awamra, 2.5 km north of Tell Biluim	0.5	78
"	"	37+	4.5 km north-west of Tell Bilium	0.3	66*
"	"	47	4 km north-east of Tell Animal	0.6	58
"	Ms 3	28	Korpt Wahden, west of Bahr El Baqar D. Road	0.6	78
"	"	30	San Baharia, 2 km south-east of Saft D.	0.3	60*
"	"	35+	Shader Azam, 2 km west of Gahr El Baqar D.	0.2	80
"	"	42+	Towia, 1 km south of Hadous Drain	0.5	78
"	"	56	Shatawy, 1 km south-east of Hadous D.	0.3	75
Port Said	Ps 1	5	0.5 km north-west of Bahr El Baqar D.	1.0	83*
"	"	14	1 km north-west of Bahr El Baqar D.	1.2	95
"	"	18	Housin No.15, 1 km north of Tarouti No.1	1.0	85
"	"	22+	2.5 km south of Tell Dibgu	0.8	82
"	"	27	1 km south of Ramses Drain	0.7	85*
"	"	29+	Malhit Um Bathy, 0.5 km to B.E.B.D.	0.8	85*
"	"	43	Shalatiyat, beside El Salam Canal line	0.7	90*
"	Ps 2	2+	Sisi, coast of a salty lake	0.5	85
"	"	11	1 km north of Tell Animal	0.7	80
"	"	12+	2.5 km north-west of Tell Animal	0.8	85
"	"	45	Malaha Sanhur, 3 km north-west of Tell Animal	0.6	88
"	"	55	5 km north-west of Tell Dibgu	1.0	100

(Cont'd)

Soil Series	Soil Type	Pit No.	Location	Elevation m	Depth of groundwater cm
Port Said	Ps 3	13	3 km east of Tell Sanhur	1.0	97
"	"	19	Midway between Ramses D. and Tarouti No.1	0.8	87
"	"	25+	1.5 km east of Tell Sanhur	1.0	100
"	"	26+	Arabi Ramses, 1 km south of Ramses D.	0.9	85
"	"	32	Salahat, 1 km north of Ramses Drain	0.9	82
"	"	33	2 km from Saft D. and 1 km from Ramses D.	0.9	85
"	"	38	3.5 km west of Tell Biluim	1.0	98
"	"	39	Hanon, 2.5 km north-west of B.E.B.D.	1.0	86
"	"	50	Taimor, 2 km south of Tell Sanhur	0.7	96
"	"	57	Amer Sand, near intersection of Ramses Drain and El Salam Canal line	0.6	94
"	Ps 4	8	3.5 km north-west of Bahr El Baqar D.	0.6	>100
"	"	15	2 km north-west of B.E.B.D.	1.0	120
"	"	16+	4.5 km south-west of Tell Biluim	1.0	90
"	Ps 5	1+	Near a salt lake, 4 km south of Tell Animal	1.0	120
"	"	3	3 km south-east of Tell Animal	1.2	>100
"	"	46	SiSi, 0.5 km south of a salty lake	1.0	90
"	"	48	Taimor, 1.5 km north-east of Taimor	0.8	>100
"	"	49	Sanhur, 1 km north-east of Tell S.	0.8	>100
Manzala	Ma 1	6	El Gabha, 2 km north-west of B.E.B.D.	2.0	>120
"	"	7	El Gabha, 1.5 km north-east of Pit 6	1.7	>120
"	"	17+	Housin No.6, near Tarouti No.1	1.2	>120
"	"	20+	Tarouti End, near Tarouti No.2	1.2	>100*
"	"	40	Gabha, 2 km north-West of B.E.B.D.	1.3	>110*
"	"	44	4.5 km north-west of B.E.B.D.	1.2	>120
"	"	53	Near Tell San El Hagar	2.0	>120

(Cont'd)

Soil Series	Soil Type	Pit No.	Location	Elevation m	Depth of groundwater cm
Manzala	Ma 2	4+	Hanon km north of Canal 67	1.5	>120
"	"	21	2 km north of Tarouti No.2	1.2	140
"	"	23+	Taimor End, 0.5 km south of Tell S.	2.0	>120
"	"	24	1 km south-east of Tell Sanhur	1.2	>120
"	"	51	1.5 km north-east of Tell San El Hagar	2.5	>120
"	"	52	2 km east of Tell San El Hagar	2.0	>130
"	"	58	Tell Biluim, north-east foot	2.0	>120
"	Ma 3	9	A ruin hill, 5 km east of T. Animal	3.0	>150
"	"	10+	Hill side, 4 km north-west of B.E.B.D.	4.0	>200
"	"	41	0.5 km east of Tell San El Hagar	3.0	>150
"	"	54+	South-western foot of Tell Dibgu	3.0	>150

Note: + Soil profile description is put in APPENDIX C-1.

* Gush water was observed above the ground water level.

2) Profile Examination

The survey points were previously selected according to the former soil maps presented by High Dam Soil Survey (1963)[7] and Suez Canal Region Integrated Agricultural Development Study (1978).[8] Due to the reasons mentioned above, many of the points were changed imperatively to find a better place for the profile examination. The following Table C-3-2 is a profile survey sheet used.

(i) Soil particle size

The survey followed the method and terms defined in the FAO Guid Lines for Soil Profile Description which is now of wider use in the world. As for soil particles, however, mechanical analysis was conducted in the laboratory following the system of U.S.D.A. Soil Survey Manual,[3] in which "Silt" reffers to particles within the size range: 0.002 to 0.05 mm instead of the international range:[1] 0.002 to 0.02 mm. Acoordingly, field designations of soil textural class by finger test often differed from actual size distribution as shown by mechanical analysis and needed to be corrected with the latter data especially in case of coarser textures. For instance, wind blown deposits prevailing all over on the soil surface gives a rough touch like sand, but mechanical analysis shows that they are rather rich in silt and clay particles, and defined as silt loam (SiL) or silty clay (SiC). This discrepancy may be derived from strong aggregation of the fine particles with soluble salts contained as high as ten percent which were estimated by means of electrical conductivity measurement.

(ii) Soil hardness tester

Moreover, a brief explanation is necessary for Soil Hardness Tester which was devised by Dr. K. Yamanaka[15] to measure hardness (compactness of strength) of soil layer and has been used extensively in soil survey work in Japan. This tester is a sort of cone penetrometer and equipped inside with a spiral spring of eight kg strength as is shown in Fig. C-3-1. The hardness is expressed by an index of cone penetration (mm) into the cut solum surface or its

Table C-3-2. Soil Profile Survey Sheet

File No.

SOIL PROFILE DESCRIPTION

Surveyer:

Pit No. Soil classification: Climate: Date:

(Soil type) Location:

Elevation: m Relief: Slope: Direction: m Parent material: Surface stones: Land use: Crops:

Drainage: Ground water: cm, deep Permeability: Erosion: Growth status & others:

Layer No.	Horizon	Depth cm	Boundary	Texture	Humus (Peat)	Soil color Dry	Soil color Moist	Mottling concretion	Structure	Compact-ness	Sticki-ness	Wetness (Gush-water)	Root distri-bution	Remarks

resistance force (kg/cm^2). The tester is handy and portable for the field survey. Compaction of the soil layers is of much importance to evaluate workability of soil in the potentiality classification as well as to distinguish genetic differences in soil classification.

(iii) Detection of oxidized manganese and iron

Two reagents were used to assist profile observation.

a) Benzidin solution: one percent solution in ten percent acetic acid solution. Oxidized Manganese such as MnO_2 form contained in the soil soon develops a dark blue color by benzidin oxidation reaction as sprayed on the profile surface.

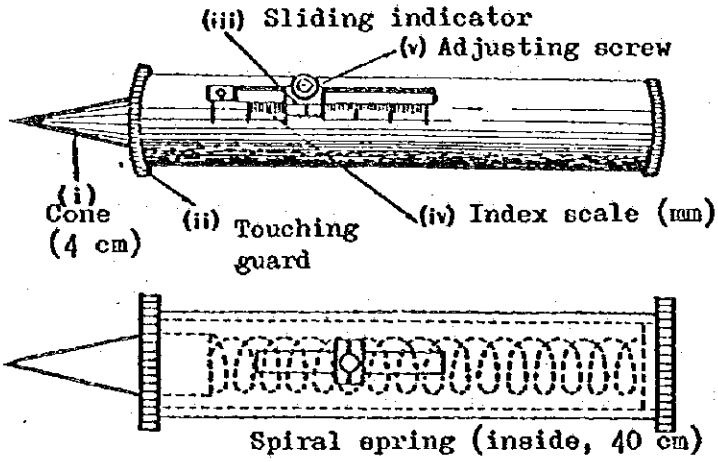
The color development though not quantative gives an information of the oxidative status of the profile and a rough estimate of manganese which can be active with the changes in oxido-redox potential of the soil.

b) Dipyridyl solution: 0.05% solution of $\alpha\alpha'$-dipyridyl in ten percent acetic acid. This reagent reacts with ferrous ion (Fe^{++}) so sensitive that can be used for its quantitative analysis. In soil survey, the reagent serves in finding reduced status of the profile by spraying it on the soil surface. Prompt development of pink-red color will indicate a highly progressed reduction potential of the solum, that is, a gleyic horizon or a remarkable high ferrous ion content.

From the survey sheets recorded in the field, representative soil profiles were selected from each of soil groups (Soil Type) to make formal descriptions. These descriptions are arranged in APPENDIX C-1.

3) Hand Boring Survey

In the beginning, borings were planned to be used at the later period of the survey to determine boundary of each Soil Type. It was found, however, that the hand auger (post-hole type) was not suitable in this area due to the very high hardness of the clayey layers. Consequently, boring



(Cited from: Bulletin of the National Institute of Agricultural Sciences, Japan, Series B, No. 14, p. 285, 1964)

Fig. C-3-1. Design of Soil Hardness Tester

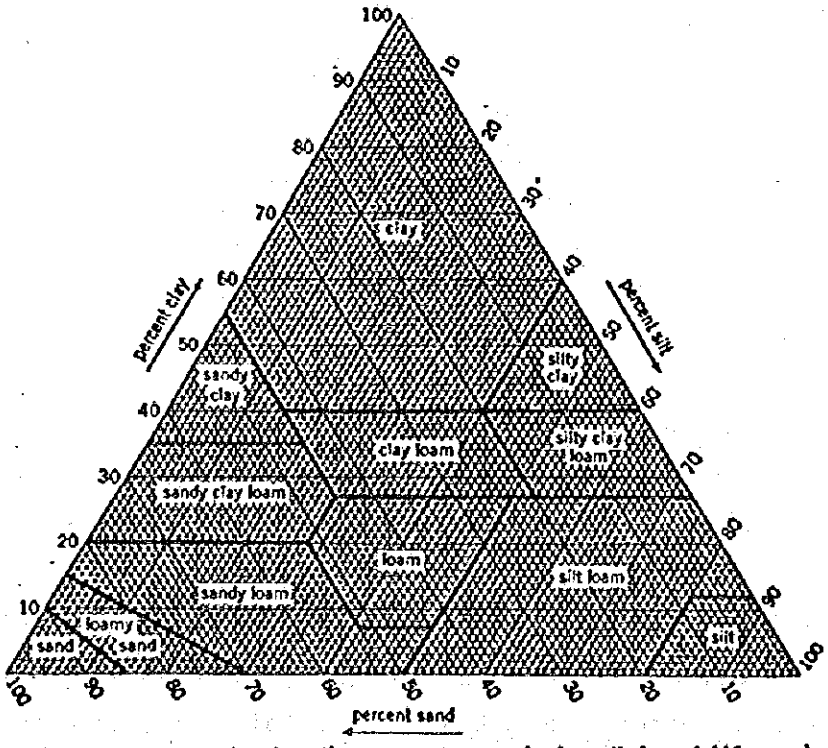


Chart showing the percentages of clay (below 0.002 mm.), silt (0.002 to 0.05 mm.), and sand (0.05 to 2.0 mm.) in the basic soil textural classes.

Fig. C-3-2. Textural Classes of Soil (U.S.D.A.)

by means of shovel was done as occasion demanded, and it numbered much less than the first plan since the survey period limited the time.

A small stick-type hand borer (one meter long) may be recommended for such survey.

4) Sampling and Spot Analysis

(i) Sampling of soil and groundwater

About four kg of soil samples were taken from every soil layer distinguished on the profile; four to five samples were collected from every pit. They were air-dried and broken to pieces, then packed in polyethylene bags. Soil samples considered to represent each Soil Type were selected and sent to the Laboratory in Cairo city for further analysis. These numbered 150 in total. It must be noted that most of the wind blown sand (SiL or SiC) and salt crusts (almost pure NaCl crystals) covering the soil surface were not included because of their very common phenomena or less importance for laboratory analysis.

Groundwater was sampled, too, at every time when it came out sufficiently on the profile. More than one liter was taken into an empty mineral water bottle and stood for one day for cedimentation of fine soil particles. Clear decantates thus taken were sent with soil samples for chemical analysis. These numbered 23 in total. In addition, some kinds of surface water, that is, canal and drain water, and water of fish ponds and salty lakes, were sampled on the way of soil survey.

(ii) Spot analysis

Tentative analysis of pH and EC was conducted of these soil and water samples as soon as they were sampled, using Portable Glass Electrode pH Meter (HM-1K) and Portable Electrical Conductivity Meter (CM-1K), respectively in the base camp house at San EL Hagar. In case of soil samples, 1:5 soil-water suspension was used for pH determination and its diluted supernatant solution of selected sample was subjected

to EC measurement. After finishing the pit survey, some soil samples were used to know their behavior upon leaching excessive salt from the soil.

All of these analytical data will be given in the later chapter or APPENDIX C-4.

C-3-2 Laboratory Analysis

According to the schedule of the survey, soil samples taken from 36 pits and groundwater samples from low level pits were sent in two portions to the Soil and Water Research Institute, Ministry of Agriculture. The Laboratory Staff of Ministry of Land Reclamation working there carried out intensively chemical and physical analyses since October, 1980.

1) Physical Analysis

(i) Mechanical analysis (< 2 mm)

Particle size determination: >0.05 mm Sieve method
<0.002 mm Pipette method
Textural class : USDA Soil Survey Manual[3]
(See Fig. C-3-2)

(ii) Water holding capacity

Saturation percentage (SP): Richards' method (1969)[5]
Field capacity ≒ SP/2 (about pF 2.7)
Wilting capacity ≒ SP/4 (about pF 4.2)
Available water ≒ SP/4 (pF 2.7-4.2)

2) Chemical Analysis

(i) pH: By pH meter with glass electrode on saturated soil extract and 1:2.5 soil-water suspension.

(ii) Electrical conductivity (EC): By conductivity meter on saturated soil extract.

(iii) Analysis of saturated soil extract: Richards' method 1969[5]

a) Anions

HCO_3^- : By titration with HCl

Cl^- : By titration with $AgNO_3$

SO_4^{--} : Difference between cations and anions

b) Cations

Ca^{++} and Mg^{++} : By titration with versenate

Na^+ and K^+ : By flame photometer

(iv) Calcium carbonate : By calcimeter

(v) Cation exchange capacity (CEC): By ammonium acetate method

(vi) Gypsum content : Difference between Ca + Mg in saturated soil extract and Ca + Mg in 1:100 soil-water extract.

(vii) Soluble nitrogen : Soluble in 1:20 soil-1% phosphoric potassium solution

(viii) Soluble phosphorus : By Olesen's method

C-4. SOIL CHARACTERISTICS AND CLASSIFICATION

C-4-1. Great Soil Groups

According to the World Soil Map complied by FAO-UNESCO (VI-2, 1977),[2] soils of the Project Area are included in Solonchaks, which occupy one belt of the fluvio-marine flats of the Nile Delta streching from Suez Canal to Alexandria.

In parallel with this belt, soils of Eutric Regosols (Re 1-1b) form the northern sea coast facing the Mediterranean Sea. Most of the Nile Delta behind the Project Area are covered with alluvial clayey soils which belong to Calcaric Fluvisols (Jc 26-2/3a).

Solonchaks develop in the quaternary alluvial and lacustrine deposit, assuming a higher salinity and heavy sodium saturation. These are classified in the Map as Gleyic Solonchaks (Zg 9-3a). Yet the gleyzation seems not so severe as far as surveyed in the Project Area, probably due to the lower microbial activity under a higher salinity.

Fig. C-4-1 illustrates the distribution of these great soil groups around the Delta area.

C-4-2. General Soil Feature of the Area

1) Influence of Groundwater

The fluvio-marine deposits covering the Area are of recent origin, low lying and therefore, badly drained and very saline under the extremely low rainfall which accelerates up-ward movement of salts with high water table throughout the year. The sedimentation process in shallow lagoonal type is still operative at present near Lake Manzala, although at a very lower rate than before the construction of Aswan High Dam. Level of the surface water surrounding the lowest parts of the area changes seasonally in 30 cm range, reaching the highest in December. Therefore, this deviation is not affected by the sea water level but by Lake Manzala level which fluctuates with waste water of many drains from the upper areas.

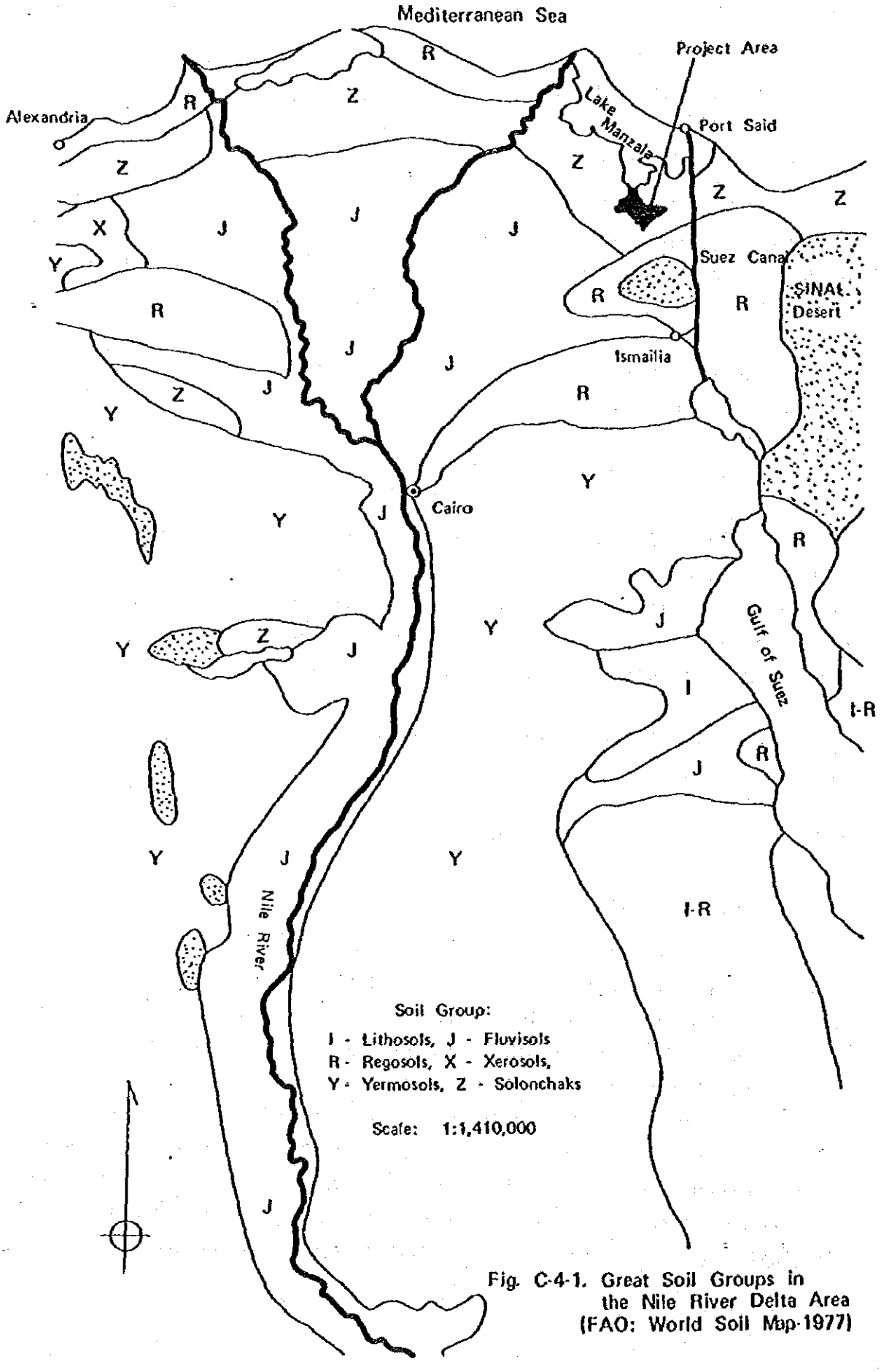


Fig. C-4-1. Great Soil Groups in the Nile River Delta Area (FAO: World Soil Map-1977)

According to the present survey, this area as a whole is presumably changing its course to dry condition from the evidences that ground water often appears much lower than surrounding land water surface near the water's edge and its level is going up along the higher altitudes of the lands. These may also indicate a dominate influence of groundwater flow from the nearby higher areas and cause severe salt accumulation in the upper part or at the surface of the soil all over the area except for the parts under water or the already cultivated lands along the border lines.

2) Wind Blown Deposits

First common feature of the soils is the wind blown puffy sand covering the soil surface and moving place to place over the flat lands. Their accumulation takes place where samll shrubs are growing. Among the shrubs, Tarrfa in Arabic is the most common species: Tamarix Nilotica Ehrenb. (Bunge-Tamaricaceae), the most tolerant to salinity. They grow up more than two m high, the trunks being about ten cm thick. With their growth, however, the wind blown deposits frequently bury them to death since the deposits still contain salts as high as ten percent.

3) Gypsum Crystals

Second feature of the Soil surface is scatterings of gypsum flakes either samll, one to five mm or big, two to five cm long. These are crystals of $CaSO \cdot 2H_2O$ and light yellowish blown in color (10YR 6/4) though samll wheathered flakes are whitish. Their origin is considered as sea bottom deposits in a lagoon. When the coast line moved north, the sea bottom became dry and, as a consequence of high evaporation in a hot dry climate, gypsum crystallized at the surface. Because of the floating character with a low gravity, they might be shifted with up and down of the flood fronts. Another source might be the underlying tertiary formations which are also very gypsiferous.

Same gypsum flakes, rather fresh crystals, are often observed to be inlaid in random directions down to one meter of the soil profiles, giving also an evidence of transportation with clayey soil materials.

Another feature of gyosum is the frequent appearance of samll crystalline forms in the subsoil; when very fine crystals are making aggregate two to three mm wide, they assume white colour, while granular crystals one to four mm long which are developing on the structure surface show dark brown colour. This crystallization may indicate that the lands are tending towards more drying conditions although it does not always mean downward movement of the soil water.

As will be described later, gypsum contents of the soil samples were analysed to show a range from one to 17%. Because of the very low solubility (0.2%), most of the solum must be saturated with $CaSO$. It is not sure but more reasonable to predict that small gypsum crystals formed in the soil would have a more active function in the process of leaching land than those transported into the soil.

4) Surface Salt Crust and Puffy Feature

When a land become dry, salts contained in subsoil or in groundwater accumulate in the top soil through capillary movement and evaporation. Consequently, salt crusts formed on the uppermost of the profile are white or brown in color being stained with wind blown puffy deposits, and generally from two mm to two cm thick. Sometimes on the wet lowland or the salty lake's edge, thick crusts split to form a characteristic tortoise-shell shape. Some of these shells are as thick as ten cm and consist of almost pure NaCl crystals.

On a slightly higher land where groundwater comes up only in the water-rising season, the top soil assumes a puffy structure which is single grained, having a mixture of fine needle salt crystals and coagulated soil particles. Sometimes a thin crust still remains on uppermost of the puffy layer.

5) Structural Development of Soil Horizons

In general alluvial materials accumulate in many layers, soil formation of which is very slow so far as they are covered with water, only giving AC type in horizon sequence system. After coming up over the

water level, they start to differentiate under soil forming conditions, in due time showing the matured horizons of ABC type.

In soils of the Project Area, no apparent horizon sequence was observed in the profile survey because each of soil layers consists of different alluvial origins though they resemble each other in color and texture. Yet soil formation by which Solonchaks were formed in the Area undoutedly has proceeded in two ways as follows:

(i) Upward movement of salts (above-mentioned)

(ii) Seasonal change of water content

The latter function will make dry and wet status of solum and cause dispersion and coagulation of clayey materials, resulting in more or less structural development in soil layers.

In fact, many grade of structure, weak to strong were observed of most of the layers above groundwater level. Such structure will be stable so long as high saline status of the soil is maintained. As soon as leaching starts, the soil will take a way to change to Solonnetzs from Solonchaks. This problem will be again discussed in the later chapter.

6) Mottlings of Mineral Oxides

The presence of color mottling in a soil profile is one of the significant characteristics in relation to genesis and drainage. In the Area it was not rare to recognize mottlings of iron and manganese oxides on the surface of structure-developmed layers.

This phenomenon results from changes of oxido-redox potential with relation to dry and wet soil condition. It should be noted that strong color development with benzidine reagent was observed on most of the soil layers even though no mottlings were visible. This would also indicate that the Area is relatively in a dry condition of soils after some periods of wet condition which lapsed in the alluvial deposition.

C-4-3. General Soil Profile

Fig. C-4-2 illustrates typical soil profile based on the observations mentioned hitherto. In principle, use of the horizon system calls for interpretation of the genetic significance of observed soil characteristics. Of this profile, however, it is not always to give a valid horizon nomenclature to each of the layers.

Surface puffy salty layer together with next layer may be called A horizon though there is no possible organic matter production or loss of clay and iron. Subsoil layers correspond to different C horizons but often show B horizon-like feature with structure or mottlings and sometimes with gley spots. Anyway, fundamentally such profile may be described to have AC type. For these reasons horizon nomenclatures for each layer were omitted in the profile description (APPENDIX C-1).

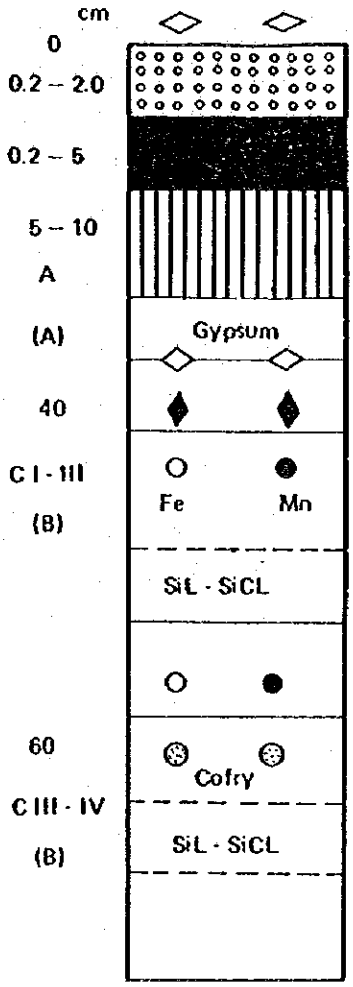
Much different from ordinary soil survey, it is very characteristic in this soil desert area that there are almost no apparent stones or vegetations on the examined sites. Effervescence of carbonates with dilute HCl was also no detectable or very feeble except for a few cases where some bivalve or spiral shells scatter on the soil surface.

C-4-4. Classification of Soil Series

Based on results of the profile examination, classification of the soils was conducted as follows.

The division of the soils into Series units in this Area is largely founded on their drainage status in relation to the topography and texture of subsoil. Names of the Soil Series followed the same ones which had been adopted in the High Dam Soil Survey (1963)[7]:

Series Name	Elevation m	Depth of groundwater cm	Subsoil texture
Clay Swamp (Ms)	0-0.6	0- 80	C
Port Said (Ps)	0.6-1.2	80-120	C (SiCL)
Manzala (Ma)	1.2-3.0 <	120-150 <	SiL-SiCL



0. Gypsum flakes

1. Wind blown deposit, SiL - SiC, 10YR 4/4

2. Salty crust, aggregates of NaCl crystals

3. Puffy layer, mixture of NaCl crystals and clay particles (wind blown), 10YR 4/3

4. Surface (40 cm) Layer, C - SiC, 10YR 3/3, weak to strong blocky (platy) structure with some Mn and Fe oxides mottlings, and gypsum flakes and crystals

5. Subsoil (below 40 cm), C - SiC, 10YR 3/2, moderate to strong blocky structure with some Mn or Fe oxides mottlings, few sandy spots (Cofry), 10YR 4/4

(See Fig. C-4-3)

Fig. C-4-2 Typical Soil Profile Diagram in the Area

1) Clay Swamp Series

The soils of Clay Swamp Series occupy the lowest lying lands which are frequently flooded or under water all the year round. They have clay to silty clay loam upper soil (0 - 40 cm) and clay lower soil (more than 40 cm) showing gleyic spots or gley horizon within one meter depth. Their structural development is the least among the Series though in the deep subsoil fairly stable structural aggregates are observed. The Clay Swamp soils are both saline and alkali, although their salinity is the lowest among the Series. They generally lack the very highly saline "flufty" feature on the top layer because of the frequent flooding and associated surface leaching. Salt content is very low ranging less than ten percent in top layer and decreases to sea water level in subsoil.

The salt concentration of the ground water are in most cases so low as two to five percent. These contents are less than one third of those in the other Series. As a result, pH of the soil ranks at the highest value from 7.8 to 8.2.

Most of the soils in this Series are located close to Lake Manzala, covering more than one third of the whole Area.

2) Port Said Series

This Series represents the Soils which occupy intermediate elevations from 0.8 to 1.2 m with corresponding physical and chemical properties. Features of the top soil are characteristic varying from crust (crack) to puffy structure which result from hydraulic status of the land affecting salt accumulation as well as its crystalization with soil particles. Salt content ranges from ten to 20% in the subsoils and five to 20% in the groundwater. Crust or puffy layer on the top gives very high salt contents which may range between 30 and 60%.

Second characteristics in the profile are the extensive presence of gypsum crystals and oxidized manganese or iron mottlings. Gypsum crystals can be distinguished between transported thin flake ones and freshly originated ones in the soil. The formers are very often visible on the surface over broad land of this Series.

Structural development is rather good in this Series, presumably resulting in a comparatively higher permeability specially in horizontal water movement within layers where platy structure proceeds. A little more than one third of the Area is classified into this Series, mainly occupying central parts.

3) Manzala Series

Soils belonging to this Series have the best internal drainage. They lie at the highest elevation within the Area including medium to high clay dunes and hummocks more than two m high around ancient sites (Tells).

The upper five to 15 cm usually display a thick puffy structure in which abundant needle crystals of sodium chloride are mixed with coarse soil aggregates. Excluding this top layers, the subsoil is still so saline as the former series. A strong medium to fine blocky structure develops in the lower subsoil with some oxidized mottlings, probably permitting a drainage of the land.

Distribution of the soils of this Series is in the proximity to the high cultivated lands along the southwesterly border line and the several Tells. The acreage is about one fifth of the whole Area.

C-4-5. Classification of Soil Types

The division of Soil Series into Soil Types is mainly based on features of top soil, texture sequence and structural development with reference to salinity and oxido-redox status of subsoil. Vegetation is a very good landscape; plant species and their growth status present better informations on salinity and water availability in the soil. Main wild plants growing within the Area are largely graded as following Table C-4-1 for their salt tolerance in relation to Soil Series.

Table C-4-1 Tolerance of Wild Plants to Salinity

Plants	Salt tolerance 1/	Water demand 2/	Soil Series
Tarffa	1	1	Ps-Ma
Cherithe	2	2	(Ms)-Ps
Hadadi	3	4	(Ms)
Phragmites	1	3	Ms-Ps-Ma
Sedge	5	5	Ms
Bulrush	4	5	Ms

Note: 1/ strong - weak, 1 - 5
2/ small - plenty, 1 - 5

In the Table, Tarffa is a Arabic name and its species is Tamarix nilotica Ehrenb (Bunge-Tamaricaceae). Both cherithe and Hadadi are also Arabic names and may belong to the species of salicornia (chenopodium).

Since there are virtually many variations in combination between plants and soil conditions, it was somewhat difficult to use vegetation as a classifying factor.

Thus, results of profile examination offered the most available data. Fig. C-4-3 arranges the column diagram of each soil profile corresponding to the Soil Type. Table C-4-2 indicates representative characteristics useful for the subdivision.

These are,

a) Depth of groundwater
b) Soil surface feature (crusty - puffy)
c) Texture of surface soil (0- 40 cm)

The other properties such as mottlings and salt content would better participate in the classification as well as in the evaluation of soil productivity which becomes important after land reclamation.

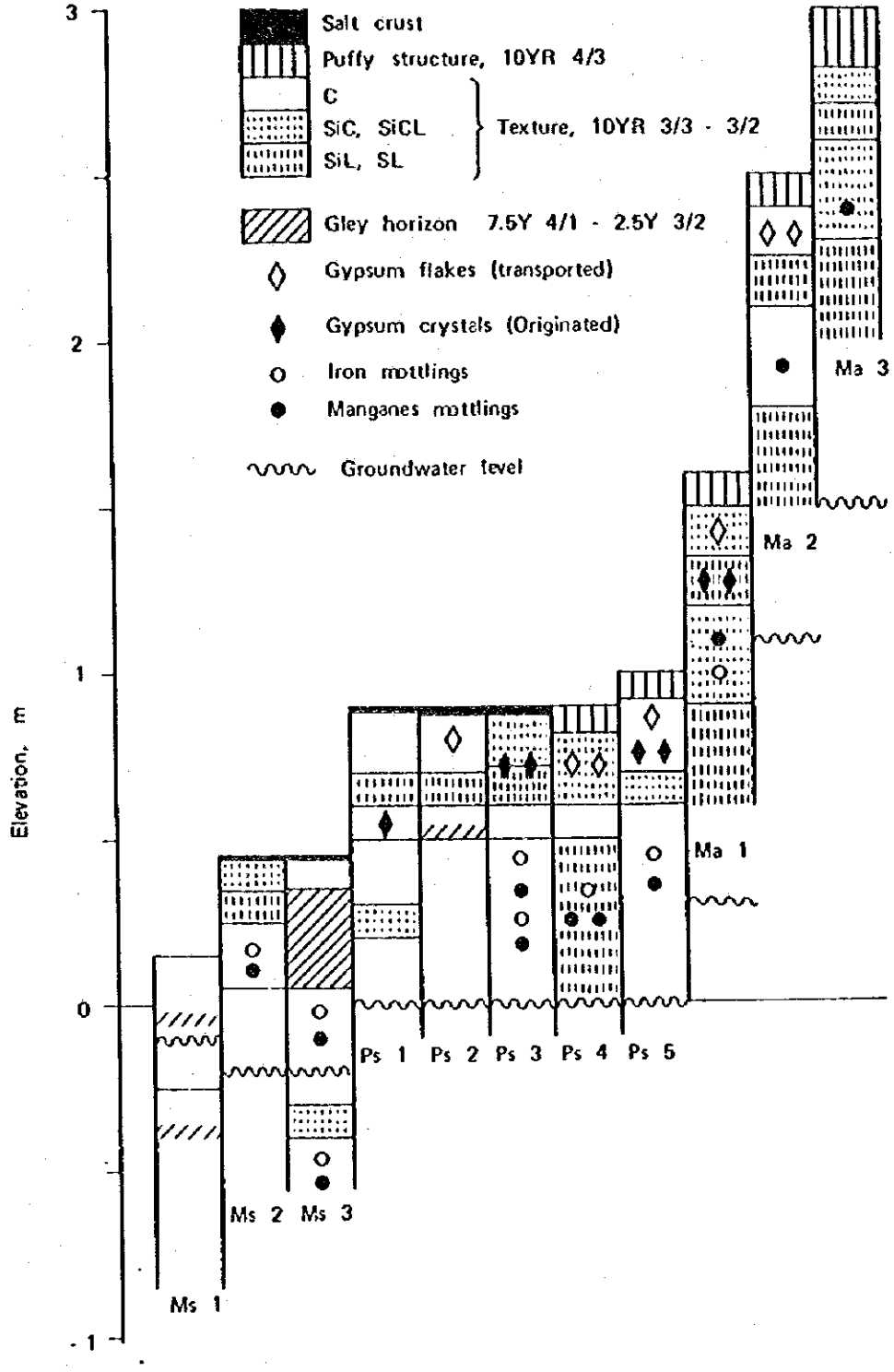


Fig. C-4-3. Profile Diagram of Soil Types

Table C-4-2 Distinguished Soil Profile Characteristics and Classfication of Soil Types

Soil Series	Elevation (m)	Depth of groundwater (cm)	Surface feature (cm)	Texture		Mottlings and Gley	Soil Type
				Surface (0-40cm)	Subsoil (40-100cm)		
Clay Swamp	0-0.3	0- 50	No salt crusty	C	C	(Gley spot)	Ms 1
	0.3-0.6	50- 80	Salt crusty (0-0.4)	SiL, SiCL+C	C	Fe or Mn	Ms 2
"	"	"		C	C (SiC)	Gley horizon	Ms 3
Port Said	0.6-1.2	80-120	Salt crusty (0.4-1.0)	C (SiL, SiCL)	C (SiCL)	None	Ps 1
"	"	"	Salt crusty (1-2)	C (SiC)	C	(Gley spot)	Ps 2
"	"	"		SiL, SiCL (C)	C (SiCL)	Fe or Mn	Ps 3
"	"	"	Puffy (2-6)	SiCL (C)	SiL (C)	Fe or Mn	Ps 4
"	"	"		C (SiC)	C	(Fe + Mn)	Ps 5
Manzala	1.2-2.0	120-150	puffy (3-10)	L, SiC	SiL, SiCL	(Fe or Mn)	Ma 1
"	2.0-3.0	"		C + SiL	C + SiL	(Mn)	Ma 2
	> 3.0	> 150	puffy (6-20)	SiL, SiCL	SiL, SiCL	(Mn)	Ma 3

Notes: In texture, + and ( ) show frequent complex and inclusion of different horizons, respectively. In mottlings, ( ) does not mean every time appearance of them.

C-4-6. Soil Types in Clay Swamp series

Common properties: Subsoil C; moderate blocky structure; scattered cherithe and other plants.

Ms 1 - Groundwater 0 - 50 cm; low salt content; some gley spots.

Ms 2 - Groundwater 50 - 80 cm; thin crusty surface; upper soil SiCL; medium salt content.

Ms 3 - Groundwater 50 - 80 cm; weak salt-tolerant plants; thin crusty surface; gley horizon; very low salt content; some Fe and Mn mottlings; high pH (8.2).

Soils of Ms 1 are very poorly drained or water covered the whole year; those of Ms 2 are located on the higher lands bordering on Ms 1 soils. Ms 3 mainly occurs in the fish pond areas where frequent supply of the drain water contributes to leaching of the lands.

Ms 3 and Ms 4 which had been grouped by FAO survey (1963)[7] could not be identified in this study.

1) Ms 1 Soil Type

Characteristics of this type are as follows:

The surface soil is dark greish brown (10YR 3/3) fine clay, moderate coarse blocky or platy, and soft to slightly hard (10-12).

The subsoil is very dark greish brown (10YR 3/2) very fine clay, strong coarse blocky, and hard (15), sometimes with few gley spots (10YR 4/1).

Physical and chemical analysis

Profile No.34

Soil Sample	Mechanical analysis				CEC	$CaCO_3$	Gypsum
	Clay %	Silt %	Sand %	Texture	me	%	%
Surface	58	33	9	C	20.5	1.8	2.6
Subsoil	70	25	5	C	-	0.4	10.8

Soil Sample	Saturated paste		Saturation extract				
	SP	pH	EC	Ca++	Mg++	Na+	SAR
Surface	72	8.2	19-81	75-134	165-450	130-1,040	12-61
Subsoil	81	8.2	29	85	200	290	24

Notes: Followings are explanations common to all of Soil Types on these series of table up to Ma 3.

(1) Soil sample: Surface (0-40cm); subsoil (below 40cm)

(2) Figures give average of consisting soil layers, but if much deviate, show their range. In general, the highest value corresponds to the uppermost sample. (For detailed data, see Appendix C-1)

(3) CEC: Cation exchange capacity, me/100 g soil
SP : Saturation percentage
EC : Electrical conductivity, mmhos/cm at 25°C
Cations (Ca, Mg, Na): me/liter
SAR: Sodium adsorption ratio

2) Ms 2 Soil Type

Characteristics of this Type are as follows:

The surface soil is covered with thin salt crust and dark greish brown (10YR 3/3) silt loam to clay, moderate medium and coarse blocky, and soft to slightly hard (7-12), with few iron or manganes mottlings.

The subsoil is very dark greish brown (10YR 3/2) very fine clay, strong coarse blockly and hard (15).

Physical and chemical analysis:

Profile No.31

Soil Sample	Mechanical analysis Clay %	Silt %	Sand %	Texture	CEC me	$CaCO_3$ %	Gypsum %
Surface	30	65	5	SiCL	29	1.6	7.8
Subsoil	75	20	5	C	42	1.8	7.1

Soil Sample	Saturated paste SP	pH	Saturation extract EC	Ca++	Mg++	Na+	SAR
Surface	38	8.4	88-147	265-583	665-920	725-1,328	34-49
Subsoil	83	8.0	29	74	121	375	38

3) Ms 3 Soil Type

Characteristics of this Type are as follows:

The surface soil is covered with thin salt crust and brown to dark brown (10YR 4/3) and greish olive (7.5Y 4/1) very fine clay, weak to strong coarse blocky, and soft to slightly hard (7-12) with few iron mottlings.

The subsoil is almost similar to the surface soil, but clay to silty clay, and slightly hard to hard (12-17) with few manganese mottlings.

Physical and chemical analysis:

Profile No.35

Soil Sample	Mechanical analysis Clay %	Silt %	Sand %	Texture	CEC me	$CaCO_3$ %	Gypsum %
Surface	75	20	5	C	39	4.3	8.1
Subsoil	63	32	5	C	-	0.5	2.1

Soil Sample	Saturated paste SP	pH	Saturation extract EC	Ca++	Mg++	Na+	SAR
Surface	79	8.2	15-51	18-185	72-335	130-495	19-31
Subsoil	81	8.4	16	23	84	160	22

C-4-7. Soil Types in Port Said Series

Common properties: groundwater 80 - 120 cm; nearby scattered Tarffa or Cherithe; lower subsoil C(SiCL); moderate to strong blocky structure; medium to high salt content;

In the former classification by FAO (1963)[7] and UNDP (1978)[8] this Series were divided into 3 Types based on the difference in flooding frequency, top soil feature and vegetation. Because of the variance in these items, 5 Soil Types were settled with reference to the other properties such as texture, salt content and gypsum crystals. They occupy the central parts of the area; Ps 1 and Ps 3 are situated adjacnet to Ms 3 and Ms 2, respectively.

Soils of Ps 2 are sometimes found in a depression extremely rich in salt content, where evaporation dominates water supply. In the salty lake surrounded by such soils, many big white crystalline blocks are observed and being collected for sale as table salt.

1) Ps 1 Soil Type

Characteristics of this Type are as follows:

The suface soil is covered with thin salt crust and dark greish brown (10YR 3/3) fine clay to silty clay loam, moderate to strong coarse blocky, and soft to slightly hard (8-12) with few white gypsum crystals and sometimes gleyic spots.

The subsoil is dark greish brown (10YR 3/3) fine clay (silty clay loam), moderate coarse blocky, and hard to very hard (15-18).

Physical and chemical analysis:

Profile No.22

Soil Sample	Mechanical analysis Clay %	Silt %	Sand %	Texture	CEC me	$CaCO_3$ %	Gypsum %
Surface	51	36	13	C	36	1.1	4-12
Subsoil	53	31	16	C	-	1.3	0.8

Soil Sample	Saturated paste SP	pH	Saturation extract EC	Ca++	Mg++	Na+	SAR
Surface	58	7.5	47	180	361	391	28
Subsoil	62	7.7	32-52	215	296	493	32

2) Ps 2 Soil Type

Characteristics of this Type are as follows:

The surface soil is covered with moderately thick salt crust (crack) and dark greish brown (10YR 3/3) very fine clay (silt loam), moderate to strong medium blocky, and soft (7 - 9), sometimes with few gleyic spots (7.5Y 4/2) and gypsum flakes.

The subsoil is very dark greish brown (10YR 3/2) very fine clay, moderate to strong medium blocky, and hard (12 - 15), with few manganese mottlings.

Physical and chemical analysis:

Profile No.2

Soil Sample	Mechanical analysis Clay %	Silt %	Sand %	Texture	CEC me	$CaCO_3$ %	Gypsum %
Surface	69	23	8	C	19	0.6	4.9
Subsoil	70	22	8	C	-	0.4	8.6

Soil Sample	Saturated paste SP	pH	Saturation extract EC	Ca++	Mg++	Na+	SAR
Surface	73	7.6	38*-136	174*-390	65*-330	510*-2,011	47*-106
Subsoil	70	7.4	81	212	207	1,200	83

Note: * First layer sampled

3) Ps 3 Soil Type

Characteristics of this Type are as follows:

The surface soil is covered with moderately thick salt crust and puffy salt layer, and brown to dark brown (10YR 4/3) and dark greish brown (10YR 3/3) silt laom to silty clay loam, moderate to strong blocky (platy) and soft to slightly hard (8-12), with few gypsum crystals and flakes, and with iron or manganese mottlings.

The subsoil is almost similar to the surface soil but darker in color, fine clay (silty clay loam) and hard (12-17).

Physical and chemical analysis:

Profile No.26

Soil Sample	Mechanical analysis				CEC	$CaCO_3$	Gypsum
	Clay %	Silt %	Sand %	Texture	me	%	%
Surface	27	59	14	SiL	29	0.5	8.6
Subsoil	55	30	15	C	-	0.8	2.4

Soil Sample	Saturated paste		Saturation extract				
	SP	pH	EC	Ca++	Mg++	Na+	SAR
Surface	55	7.5	63	165	373-627	593	33
Subsoil	66	7.5	47	191	196-424	435	29

4) Ps 4 Soil Type

Characteristics of this Type are as follows:

The surface soil has a puffy structure (10YR 4/4) on the top and is dark greish brown (10YR 3/3) fine clay to silt loam, weak to moderate medium and coarse blocky, and slightly hard to hard (12-17) with few gypsum flakes.

The subsoil is almost similar to the surface soil but weak coarse blocky with few iron and manganese mottles.

Physical and chemical analysis:

Profile No.16

Soil Sample	Mechanical analysis Clay %	Silt %	Sand %	Texture	CEC me	$CaCO_3$ %	Gypsum %
Surface	27	48	25	L	18	0.5	13.9
Subsoil	12	62	26	SiL	-	2.0	1.2

Soil Sample	Saturated paste SP	pH	Saturation extract EC	Ca++	Mg++	Na+	SAR
Surface	30	7.4	70-128	109-563	391-797	900-1,800	56-108
Subsoil	41	7.6	70	120	339	928	61

5) Ps 5 Soil Type

Characteristics of this Type are as follows:

The surface soil has a puffy texture (2-6cm, 10YR 4/3) and is very dark greish brown (10YR 3/2) clay, moderate medium blocky and soft to very hard (7-20), with few gypsum flakes and crystals.

The subsoil is very similar to the surface soil but moderate to strong blocky and extremely hard (22-23), sometimes with few iron or manganese mottlings.

Physical and chemical analysis:

Profile No.1

Soil Sample	Mechanical analysis Clay %	Silt %	Sand %	Texture	CEC me	$CaCO_3$ %	Gypsum %
Surface	60	30	10	C	16.5	0.3	7.6
Subsoil	52	39	9	C	16.0	0.7	8.8

Soil Sample	Saturated paste SP	pH	Saturation extract EC	Ca++	Mg++	Na+	SAR
Surface	68	7.3	86-144	185-403	438-761	1,427	67
Subsoil	62	7.9	64.7	169	74-306	925	55-88

C-4-8. Soil Types in Manzala Series

Common properties: nearby scattered Tarffa; thick puffy surface; moderage to strong blocky structure; high salt content; Mn or Fe mottles; groundwater >120 cm; pH 7.5 - 8.0.

The UNDP Report (1978)[8] used only topography (clay dunes) for subdivision of this Series, largely resulting in similar soil types differentiated in this study.

Soils of Ma 1 and 3 have coarse textured layers within 40 cm of the surface. They seem to be in a main current of sandy deposit together with those of Ps 3 and Ps 4, running from southeasterly to westerly parts of the Area.

1) Ma 1 Soil Type

Characteristics of this Type are as follows:

The surface soil is very puffy textured (3-8cm) and dark greish brown (10YR 3/3) loam to silty clay, weak to moderate coarse blocky, and slightly to very hard (10-20) with few gypsum flakes and crystals.

The subsoil is dark greish brown (10YR 3/3) silt loam to silty clay loam, moderate to strong coarse blocky, and sometimes with few iron or manganese mottlings.

Physical and chemical analysis:

Profile No.17

Soil Sample	Mechanical analysis Clay %	Silt %	Sand %	Texture %	CEC me	$CaCO_3$ %	Gypsum %
Surface	26	53	21	SiL	21.5	0.3	1.9-7.1
Subsoil	14	69	17	SiL	-	0.6	-

Soil Sample	Saturated paste SP	pH	Saturation extract EC	Ca++	Mg++	Na+	SAR
Surface	46	7.2	52-141*	135-480*	450-834*	450-1,500*	26-59*
Subsoil	62	7.7	46	153	268	495	34

Note: * Second layer sampled

2) Ma 2 Soil Type

Characteristics of this Type are as follows:

The surface soil is very puffy textured (3-10cm, 10YR 4/4) and dark greish brown (10YR 3/3) fine clay to silt loam, moderate coarse blocky and slightly to very hard (10-22), sometimes with gypsum flakes and crystals.

The subsoil is very dark greish brown (10YR 3/2) fine clay to silt loam, moderate to strong medium blocky and extremely hard (23), sometimes with few manganese mottlings.

Physical and chemical analysis:

Profile No.23

Soil Sample	Mechanical analysis				CEC	$CaCO_3$	Gypsum
	Clay %	Silt %	Sand %	Texture	me	%	%
Surface	57	26	17	C	22.8	1.4	4.7
Subsoil	59	25	16	C	-	1.9	-

Soil Sample	Saturated paste		Saturation extract				
	SP	pH	EC	Ca++	Mg++	Na+	SAR
Surface	65	7.5	74-146	230-414	330-1,145	730-1,353	33-55*
Subsoil	70	7.9	53	188	232	640	37-58

Note: * Third layer sampled

3) Ma 3 Soil Type

Characteristics of this type are as follows:

The surface soil is extremely puffy structured (6-20cm) and very dark yellowigh brown (10YR 2/3) silt loam to silty clay loam, moderate to strong medium blocky, and hard to extremely hard (12-26).

The subsoil is almost similar to the surface soil but very hard (22), and sometimes with few manganese mottlings.

Physical and chemical analysis:

Profile No.10

Soil Sample	Mechanical analysis Clay %	Silt %	Sand %	Texture	CEC me	$CaCO_3$ %	Gypsum %
Surface	25	72	3	SiL	20.3	1.4	1.3-7.2
Subsoil	31	65	4	SiCL	22.0	2.1	0.5

Soil Sample	Saturated paste SP	pH	Saturation extract EC	Ca^{++}	Mg^{++}	Na^{+}	SAR
Surface	60	7.6	19.1	130	54	200	21
Subsoil	61	8.2	47-116*	185	148-313*	620-1,860*	50-116*

Note: * Third layer sampled

C-4-9. Soil Map Making

According to the reconnaissance character of this survey, Soil Types are designated as mapping units. They are mapped on a scale of 1:50,000 in a separate sheet, MAP C-2.

Distribution of each Soil Type was depicted by determining the border line mainly with the boring Survey and the Topographical Maps which have been made at 1:10,000 scale by the Study Team. The past soil maps by High Dam Survey (1963)[7] and Suez Region Development Study (1978)[8] were also good references for making the map.

It is well to remember that all of the Water-covered areas, though most of them were beyond out of reach this time, were reasonably classified into one or two of the adjacent Soil Types. This will make it easier to calculate the extent of soil groups and to evaluate them into Land Classes for the land reclamation purpose.

C-4-10. Distribution of Soil Types by Areas and Slopes

After soil mapping, sizes of each Soil Types were measured with a Roller Planimeter (KP-46) and summarized for three area groups. In Table C-4-3 Ms Series soils dominate in Dibgu and Biluim area while Ps and Ma

Table C-4-3 Distribution of Soil Types by Areas

Soil Type	Dibgu Area	Sanhur Area	Biluim Area	Total Acreage		
	ha	ha	ha	ha	feddan	%
Ms 1	2,700	500	2,200	5,400	12,860	17.2
Ms 2	550	660	280	1,490	3,200	4.7
Ms 3	2,710	1,310	2,160	6,180	14,700	19.7
Total	5,960	2,470	4,640	13,070	30,760	41.6
Ps 1	1,440	2,590	940	4,980	12,180	15.9
Ps 2	280	1,130	930	2,340	5,570	7.5
Ps 3	630	1,390	620	2,640	6,280	8.4
Ps 4	-	-	1,170	1,170	2,790	3.7
Ps 5	-	1,400	-	1,400	3,330	4.5
Total	2,350	6,510	3,660	12,530	30,150	40.0
Ma 1	370	860	820	2,050	4,870	6.5
Ma 2	80	2,230	780	3,090	7,350	9.8
Ma 3	30	420	210	660	1,570	2.1
Total	480	3,510	1,810	5,800	13,790	18.4
All total	8,790	12,490	10,120	31,400	-	100
feddan	20,900	29,710	24,090	-	74,700	-
%	28.0	39.8	32.2	-	-	100

Note: See Table C-2-1 and Fig. C-2-1 for division of the three area groups.

Series exceed in Sanhur area.

Soil of Ms 2 occupy the smallest patches among this Series, suggesting possibility of annexing with Ps 1 or Ps 3 in relation to their physical and chemical properties analysed. Soil of Ps 4 and Ps 5 are located almost in one patch in Biluim and Sanhur area, respectively. These are also correlative with those of Ps 2. Soils of Ma Series are limited to the slightly hilly lands mainly sloping at more than 0.2%. In total they only appear in less than one fifth of the whole Area.

Table C-4-4 shows the distribution of Soil Types by slopes. As already pointed out in this chapter, soils of Ms and Ps Series mostly distribute at less than 0.1% and 0.2-0.3% clopes, respectively. Soils of Ma Series rather scatter over at broader slope range. The reason is that a slightly steep strip often surrounding these areas was neglected to express their land slopes.

C-4-11. Elevation and Depth of Groundwater

In Fig. C-4-4, depth of groundwater (y, cm from the soil surface) is dotted against elevation (x, m above sea level) of each pit. As is given in the Figure, the following correlation equation was obtained by formal calculation:

$$y = 34.3x + 61.3 \quad (r = 0.94)$$

Using this equation, relations between both elements are recomputed in the next Table C-4-5.

Table C-4-4. Distribution of Soil Types by Slopes

Slope %	Ms 1 ha	Ms 2 ha	Ms 3 ha	Ps 1 ha	Ps 2 ha	Ps 3 ha	Ps 4 ha	Ps 5 ha	Ma 1 ha	Ma 2 ha	Ma 3 ha	Total ha	Total feddan	Total %
< 0.1	5,400	710	4,940	480	130	280	-	-	-	-	-	11,940	23,400	38.0
0.1-0.2	-	470	1,240	580	1,920	1,360	-	-	480	100	-	6,150	14,630	19.6
0.2-0.3	-	170	-	3,280	120	1,000	1,170	1,400	940	2,030	80	10,190	24,250	32.5
0.3-0.5	-	140	-	640	170	-	-	-	630	810	5	2,395	5,700	7.6
0.5-1.0	-	-	-	-	-	-	-	-	-	130	430	560	1,330	1.8
> 1.0	-	-	-	-	-	-	-	-	-	20	145	165	390	0.5
Total	5,400	1,490	6,180	4,980	2,340	2,640	1,170	1,400	2,050	3,090	660	31,400	74,700	100

Table C-4-5 Elevation and Depth of Groundwater Calculated by Correlation Equation

Elevation of the pit (cm)	Groundwater (cm)	
	Depth from soil surface	Elevation
- 176	0	- 176
- 32	50	- 82
0	63	- 63
52	80	- 28
100	96	4
111	100	11
169	120	49
200	131	69
255	150	105
300	166	134

The Table estimates that even at sites below the sea level the elevation of groundwater is still lower than that of soil surface, both finally meeting at a elevation of - 1.8 m. This may imply some important evidences such as followings on the groundwater movement although its depth is not always equal to true water table:

(i) Descontinuity of the groundwater with the surface water nearby covering the same land. This means also discontinuity with the sea water across Lake Manzala.

(ii) High salt content of the groundwater, being much higher than that of sea water, may be resulted from concentration through evapotranspiration of the seepage water from behind high plains of the Delta.

Moreover, situations of groundwater on the low lying lands will make the drainage improvement more difficult in irrigated agriculture. The areal distribution by groundwater fluctuation thus will have great usefulness when land reclamation is performed. Next Fig. C-4-5 is

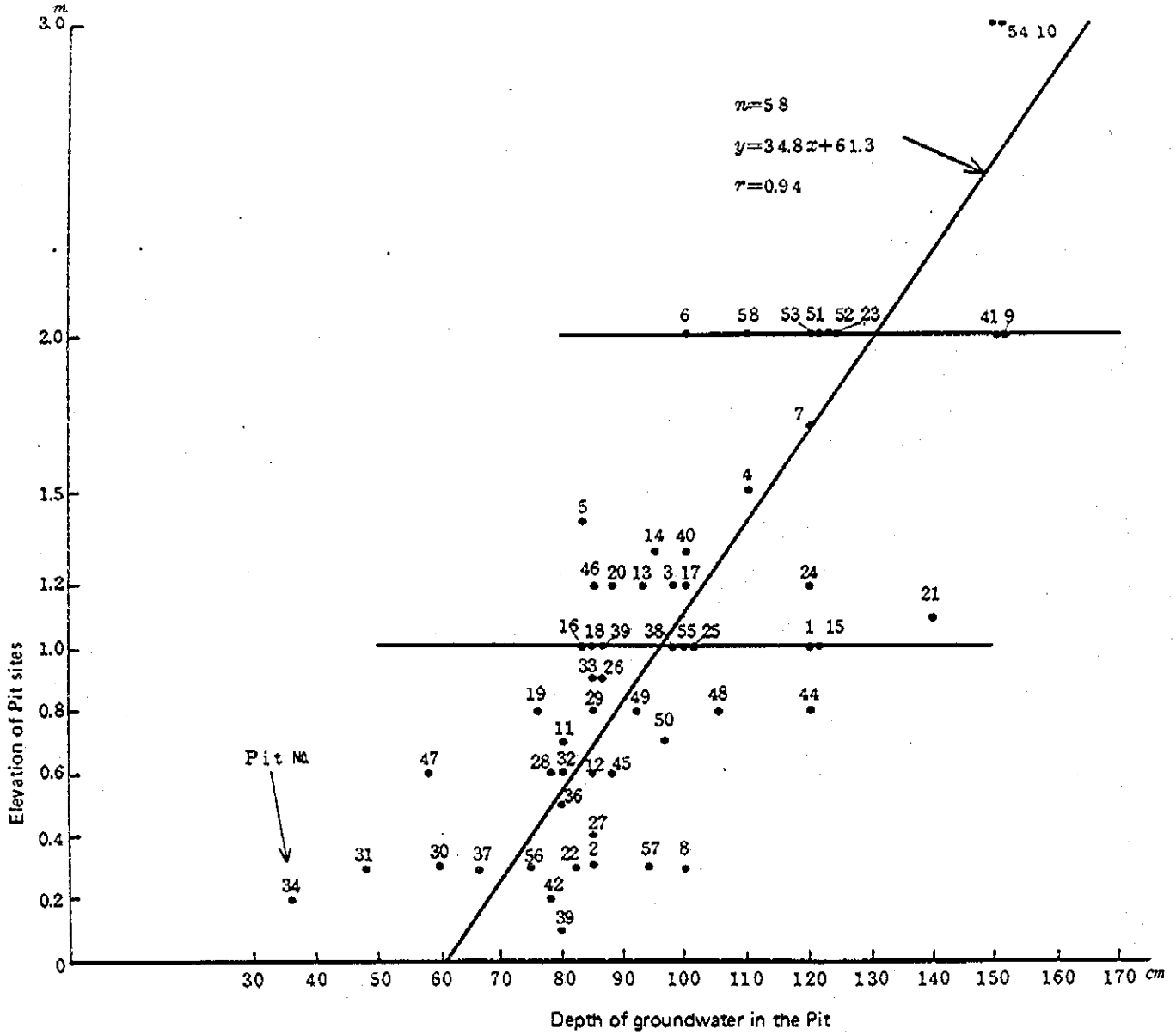
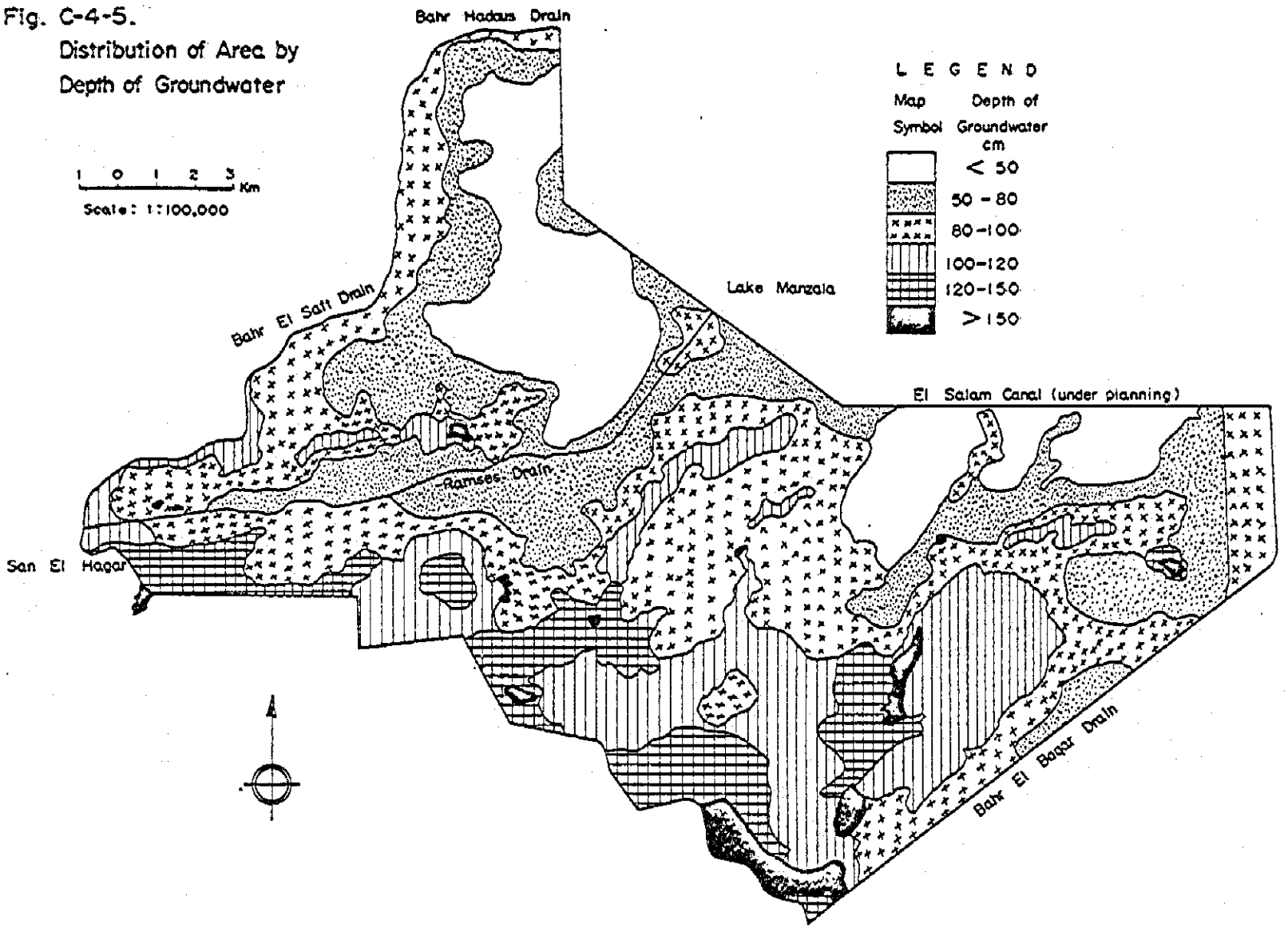


Fig. C-4-4 Relationships between Elevation and Depth of Groundwater of the Pits

drawn based on the survey data, possibly giving a practical reference for land classification.

The other factors such as distribution by soil texture and salt content will be discussed later from land-use aspect.

Fig. C-4-5.
Distribution of Area by
Depth of Groundwater



C-5. LAND CLASSIFICATION

In order to reclaim the land economically and cultivate rationally, the land should be subjected to the suitable crops and the farm management and soil improvement according to its characteristics. Land classification is the systematic appraisal of of lands and their designation by categories on the basis of similar characteristics. The lands of the Project Area can not be considered to have decisive inferiority of soil and management practices except for desalinization and drainage of them so far as results of the present Soil Survey are concerned.

From a stand-point of the purpose to establish full irrigation service lands in the Area, accurate evaluation of the soil properties will be aspired by processing in two ways, that is, classification for land reclamation and productivity in soil potentiality.

In view points of topography, geology and soil genetics, many items concerning with land reclamation and future farming should be examined as follows:

a) Elevation (m) and slope (%) - irrigation and drainage
b) Depth of ground water (cm) - drainage and fertility
c) Feature of soil surface - water status
d) Structural development - permeability and fertility
e) Texture - permeability, fertility and workability
f) Salt content of soil and groundwater - desalinization
g) Consistence (Stickiness and Hardness) - workability
h) Reaction (pH) - productivity
i) Content of gypsum - reaction, fertility and structural development
j) Mottlings and gley horizon - (Oxido-redox potential) - structural development and fertility
k) Nutrient status (N, P, K and other nutrients) - fertility
l) Presence of toxic substances - fertility

To make the classification process understandable, several items significant in dividing the soil groups may be selected.

C-5-1 Land Classification for Land Reclamation

For land reclamation, easiness of irrigation, drainage and desalinization were adopted as deciding items and permeability as subdeciding item.

1) Criteria of Evaluation Items

Soil potentiality classes as expressed as criteria of each evaluation items are summarized in Table C-5-1. Specification for their significance and criteria are described as below. These items can be divided to five classes based on their hazards and limitations appearing within the surveyed area.

(i) Drainage - depth of groundwater

Drainage is the first item in land use for irrigated agriculture. Levels of groundwater give data directly showing easiness of drainage works for the land although data seem not always to be parallel to the elevation because of very high content of salt and sometimes gush of the groundwater in the pit survey. The classes were divided by difference in water depth in accordance with those used for soil series classification. Features of the soil surface, that is, puffy or crust (crack) status due to salt accumulation, are also helpful to estimate hydraulic conditions of the soil.

(ii) Irrigation - land elevation

Elevation of the Land is a primary factor to affect irrigation system works as well as slope of the Land; the higher the more difficult to deliver the water under a gravity irrigation system as far as the level of canal water intake is designed to be lower. Although in the present plan the El Salam Canal intake weir is to be situated as high as 2 m above sea level, secondary and tertialy canals will have to run pro-

Table C-5-1. Criteria of Soil Potentiality Evaluation for Land Reclamation

Criteria Value (Limitation)	Irrigation	Drainage	Permeability				Desalinization
	Land elevation (m)	Depth of groundwater (cm)	Structural development	Texture Surface[2]	-	Subsoil[3]	Salt content ECe[1]
0 (Very good)	< 0.8	> 150	Strong	SiL, SiCL	-	SiCL	< 30
1 (Good)	0.8 - 1.2	120 - 150	Strong to moderate	SiL, SiC (+C)	-	C (+ SiL)	30 - 50
2 (Moderately good)	1.2 - 2.0	80 - 120	Moderate	C + SiCL	-	C	50 - 70
3 (Poor)	2.0 - 3.0	50 - 80	Moderate to weak	C (SiCL, SiC)	-	C (SiCL, SiC)	70 - 90
4 (Very poor)	> 3.0	< 50	Weak to massive	C	-	C	> 90

Note: 1/ Electrical conductivity, mmhos/cm at 25°C of soil saturation extract.

2/ 0 - 40 cm

3/ 40 - 100 cm

bably at 1 m level or so. Consequently, higher land than that will need some facilities for lifting water.

(iii) Permeability - structure and texture

In view of extremely high salt content of the soil all over the area, water permeability is the second item much important not only for drainage but also for desalinization of the land. This item is reasonably evaluated by combined classification of the two soil properties, structural development and texture (particle size class).
In highly developed structured soil, air space between unit peds will serve as a passage of water. In the same way, coarse textured soil will permit water movement much better than fine textured soil. The criteria are graded according to the profile survey results.

(vi) Desalinization - salt content of soil

Removal of salts from the soil is the first necessity before farming in the Area. Salt contents are divided into classes based on the profile observation and analyses of soil and ground water samples. In most of all soils salts accumulate in the surface layers as a result of longtime upward movement and surface evaporation of soil water. Low permeability due to weak structural development or heavy texture will force a longer period of frequent irrigation to leach out the soil. The criteria of this item can be expressed as electrical conductivity (EC) of saturation extract of the soil.

2) Average Item Values of Soil Types

Soil Types are taken as unit to be evaluated and their values for each items were averaged based on the result of profile survey and laboratory analyses. Table C-5-2 and Table C-5-5 in the next paragraph present these data concerning items.

3) Description of Land Classes Decided

Table C-5-3 shows the classes given to each of Soil Types according to the criteria. Land Classes are determined in this case on the total values. Distribution of areas by the Class is calculated as in Table C-5-4, and they are mapped on a scale of 1:50,000 in a seperate sheet, MAP-3. Definition of Class and areal distribution of the soil are described as follows.(7)

(i) Class I and II: Very suitable and suitable soils for irrigated agriculture

These high classes are not found among Soil Types in the Project Area. Because all of them have more or less limitations in land reclamation on the present status of the soil.

(ii) Class III: Medium suitable soils for irrigated agriculture

The soil belonging to this Class have limitations which can be met by special technical measures. Some of these limitations require special attention and effort in the reclamation stage, but most of them will result in management limitation for the farmer. The result will be a soil of lower agriculture value, the variety of crops to be grown is more limited and/or the risks of diminished yield are greater than in Class I and II.

a) Class III A: Slight soil management limitations

Soil Types, Ms 3, Ps 1 and Ps 3, belong to this sub-class. These have no severe limitation except their texture are heavy and/or ground water table is shallow. Salt content is lower or lowest among all Soil Types. Drainage and leaching management may be easier than in the other sub-classes. With its gley horizon Ms 3 would have been grouped into Class III C, but grade of gleyzation is not so strong as hazard that it may practically be included in Class III A for reasons that most of the soils are used as fish ponds distributing along the main drains and very easy to be managed with drainage system.

Table C-5-2. Average Physical Properties of Soil Types

Soil Type	Structure development	Texture			Hardness [1/2/]	Stickiness [4/]
		Surface [2/]	-	Subsoil [3/]		
Ms 1	Moderate blocky (platy)	C	-	C	10 - 12	Sticky
Ms 2	Moderate blocky (platy)	SiL, SiCL+C	-	C	10 - 13	Sticky
Ms 3	Moderate blocky	C	-	C (SiC)	12 - 14	Very sticky
Ps 1	Moderate to strong blocky	C(SiL, SiCL)	-	C (SiCL)	9 - 11	Sticky
Ps 2	Moderate to st. blocky (platy)	C(SiL)	-	C	7 - 9	Sticky
Ps 3	Mo. to st. blocky (platy)	SiL, SiCL(C)	-	C (SiCL)	9 - 12	Slightly sticky
Ps 4	Weak to m. blocky	SiCL (C)	-	SiL (C)	12 - 15	Sticky
Ps 5	Moderate blocky (Platy)	C (SiC)	-	C	7 - 18	Very sticky
Ma 1	Weak to mo. bl. or platy	SiC (L)	-	SiL (SiCL)	10 - 15	Sticky
Ma 2	Moderate blocky (platy)	C + SiL	-	C + SiL	10 - 14	Slightly sticky
Ma 3	Mo. to st. bl. (platy)	SiL, SiCL	-	SiL, SiCL	12 - 20	Slightly sticky

Note: 1/ By Yamanaka's Soil Hardness Tester
2/ 0 - 40 cm
3/ 40 - 100 cm
4/ 0 - 40 cm, when wet

Table C-5-3. Evaluation of Soil Potentiality for Land Reclamation

Soil Type	Irrigation	Drainage	Permeability			Desalinization	Total	Land Class
			Structure	Texture	Average			
Ms 1	0	4	2	4	3	1	8	III B
Ms 2	0	3	2	1	2	3	8	III B
Ms 3	0	3	2	3	3	0	6	III A
Ps 1	1	2	1	3	2	2	7	III A
Ps 2	1	2	1	3	2	3	8	III B
Ps 3	1	2	1	1	1	2	6	III A
Ps 4	1	2	3	0	2	4	9	III C
Ps 5	1	1	1	4	3	3	8	III B
Ma 1	2	1	3	0	2	3	8	III B
Ma 2	3	1	2	2	2	3	9	III C
Ma 3	4	0	1	0	1	2	7	IV A*

Note: Refer to Table C-5-2 and C-5-5.

* Special evaluation has been made since these lands are mainly ancient ruin sites on high elevation more than 3 m.

Table C-5-4. Areas of Land Classes of Land Reclamation for Irrigated Agriculture in the Project Area

Class	Sub-Class	Suitability	Soil Type	ha	feddan	%
I		Very suitable	-	-	-	-
II		Suitable	-	-	-	-
III		Medium suitable				
	A	Slight soil management limitations	Ms 3, Ps 1, Ps 3	13,800	33,160	43.9
	B	Moderate management limi.	Ms 1, Ms 2, Ps 2, Ps 5, Ma 1	12,680	29,830	40.4
	C	Severe management limi.	Ps 4, Ma 2	4,260	10,140	13.6
IV		Suitable only under special conditions				
	A	Management limitations	Ma 3	660	1,570	2.1
	B	Reclamation limitations	-	-	-	-
V		To be determined after further detailed studies	-	-	-	-
Total				31,400	74,700	100

It would not take a long time to make the lands arable for growing rice or other salinity-tolerant crops. More than 40% in total of the Area are classified into this Class A.

b) Class III B: Moderate soil management limitations

This sub-class covers all soil types of extremely high salt content which requires many efforts to finish leaching with the exception of Ms 1. The leaching needs more time than in other sub-classes, but it does not impose great difficulties because of the moderately developed structure which permits a fairy good permeability in the soils of Ms 2, Ps 2 and Ma 1, and/or of the comparatively good condition in the soils of Ps 5. Soils of Ms 1, which are much less in salt content, are specifically ranked at this Class due to the worst drainage and permeability potentials. As a whole, salinity resistant crops such as rice are recommended after leaching of the land followed by less resistant upland crops. Total areas occupied by these 5 Soil Types amount just 40% of the Area.

c) Class III C: Severe soil management limitations

Two Soil Types, Ps 4 and Ma 2, are included in this Class with their difficulties in reclamation works. Soils of the former are less evaluated due to extremely high salt content and lower structural development; soils of the latter have also some hazards of high salt content and irrigation difficulty because of their higher elevation.
Both Types will need a complete net works of drains and canals in the land with pumping facilities for drainage or irrigation. They occupy only 14% of the Area.

(iii) Class IV: Suitable for irrigated agriculture only under special conditions

Class IV A: Management limitations

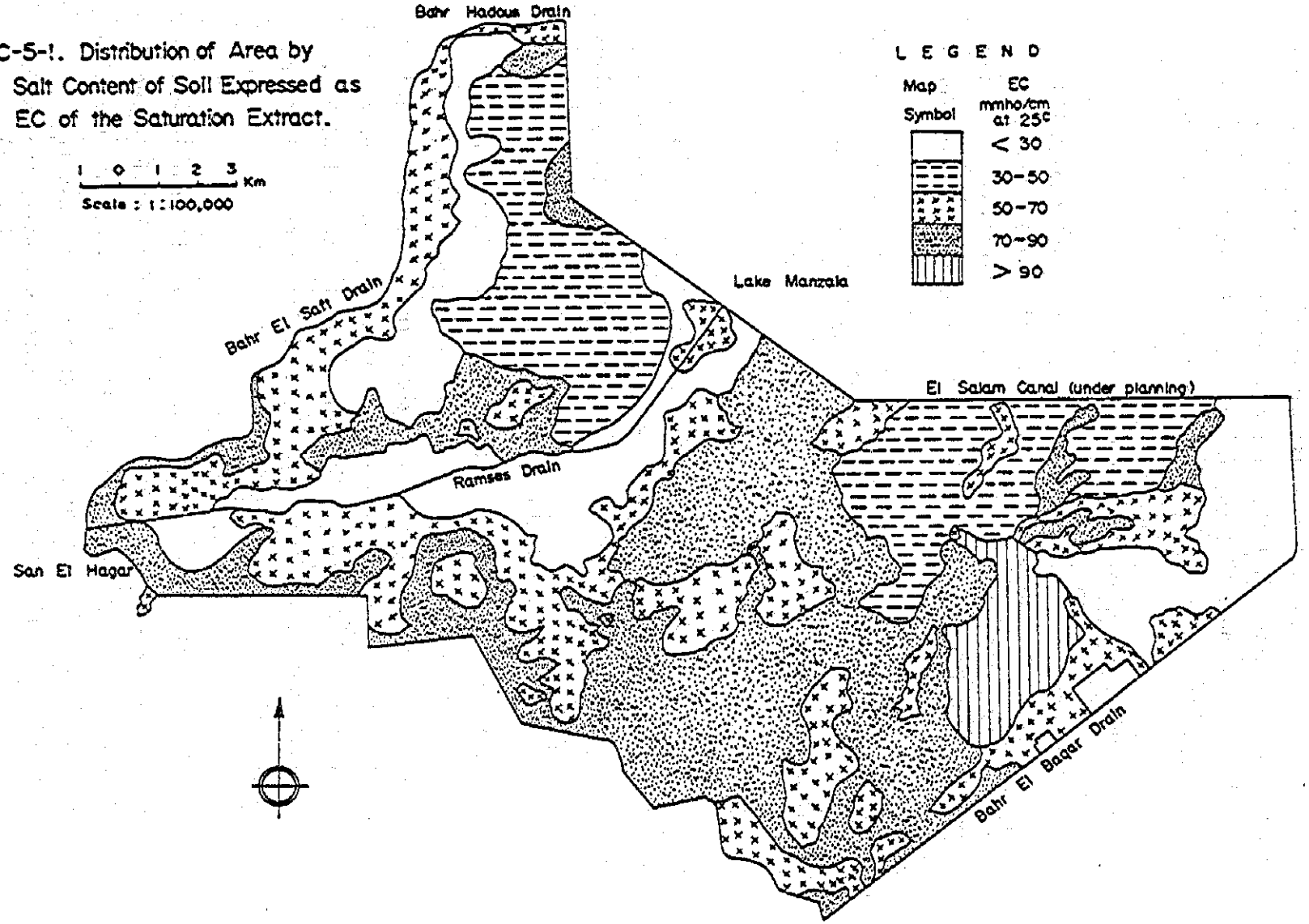
Soils of this class are of decidedly poor quality, consisting of very hard sustratum with a very deep ground water table

and also high salt accumulation. Reclamation of the land undoubtedly costs the highest among Soil Types. The hydrological properties as well as productivity of the soil are thus in no way favourable for agriculture. Only one Type of Ma 3 belongs to this class, appearing on medium to high dune area around the ancient sites (Tells). The reclamation of these lands would not be considered but preferably be left as recreation sites, and for public or residense use. Extent of this Class is very samll (2%).

4) Distribution of Area by Salt Content of Soil

From viewpoints of the characteristics of Solonchaks soils, simple evaluation of soil potentiality for land reclamation may also be possible by taking only drainage and desalinization as items. Easiness of drainage is refered to Fig. C-4-5 in the foregoing chapter when expressed as depth of groundwater. As for desalinization salt content of the Soil Types can be used in term of EC. Even the lowest class, less than 30 mmhos, is much higher than the permissible range of 4 to 8 mmhos. As is clear from Fig. C-5-1, salts are concentrated on the lands elevations of which are somewhat higher than the adjacent water-covering areas and/or where higher lands extend surrounding them. Soils of Ma 3 are not so rich in salts because of their highest elevation.

Fig. C-5-1. Distribution of Area by Salt Content of Soil Expressed as EC of the Saturation Extract.



C-5-2. Land Classification for Soil Productivity

Second evaluation of land class was tried for soil productivity after land reclamation is finished including leaching process. Accordingly, soil productivity should be dealt with soil characteristics in relation to its fertility and easiness of field operation.

1) Average Soil Characteristics of Soil Types

In order to investigate soil characteristics concerning soil productivity, results of physical and chemical analysis were used to get average values over surface 40 cm of the profile. The depth of 40 cm is considered to be sufficient for supporting plant growth.

These values are arranged in Table C-5-5 and C-5-6 for chemical properties, together with Table C-5-2 for physical properties which was presented in the preceeding chapter.

2) Criteria of Evaluation Items

In connection with the data thus obtained in these Tables, criteria of some evaluation items are summarized in Table C-5-7 and C-5-8. Specification for their significance are described as follows.

(i) Workability - stickiness and hardness

Workability here means efficiency or suitability of soil to farm opperation such as plowing and ridging. Both items represent important qualities of consistence when the soil is wet or dry. Stickiness shows adhesion of the soil material to other objects, its grade in general being in parallel with clay and silt contents. Fig. C-5-2 shows distribution of clayey and silty soil area by Soil Types.

Soil hardness was measured by tester in the profile examination. It expresses resistance of the soil material in the field condition, affecting workability in many way whether with small tools or big machines. Another aspect of this item relates to its inhibition to root growth, naturally the harder the more severe. Based on the research results[17, 18] criteria

Fig. C-5-2
Distribution of Area by Soil Texture and Soil Types.

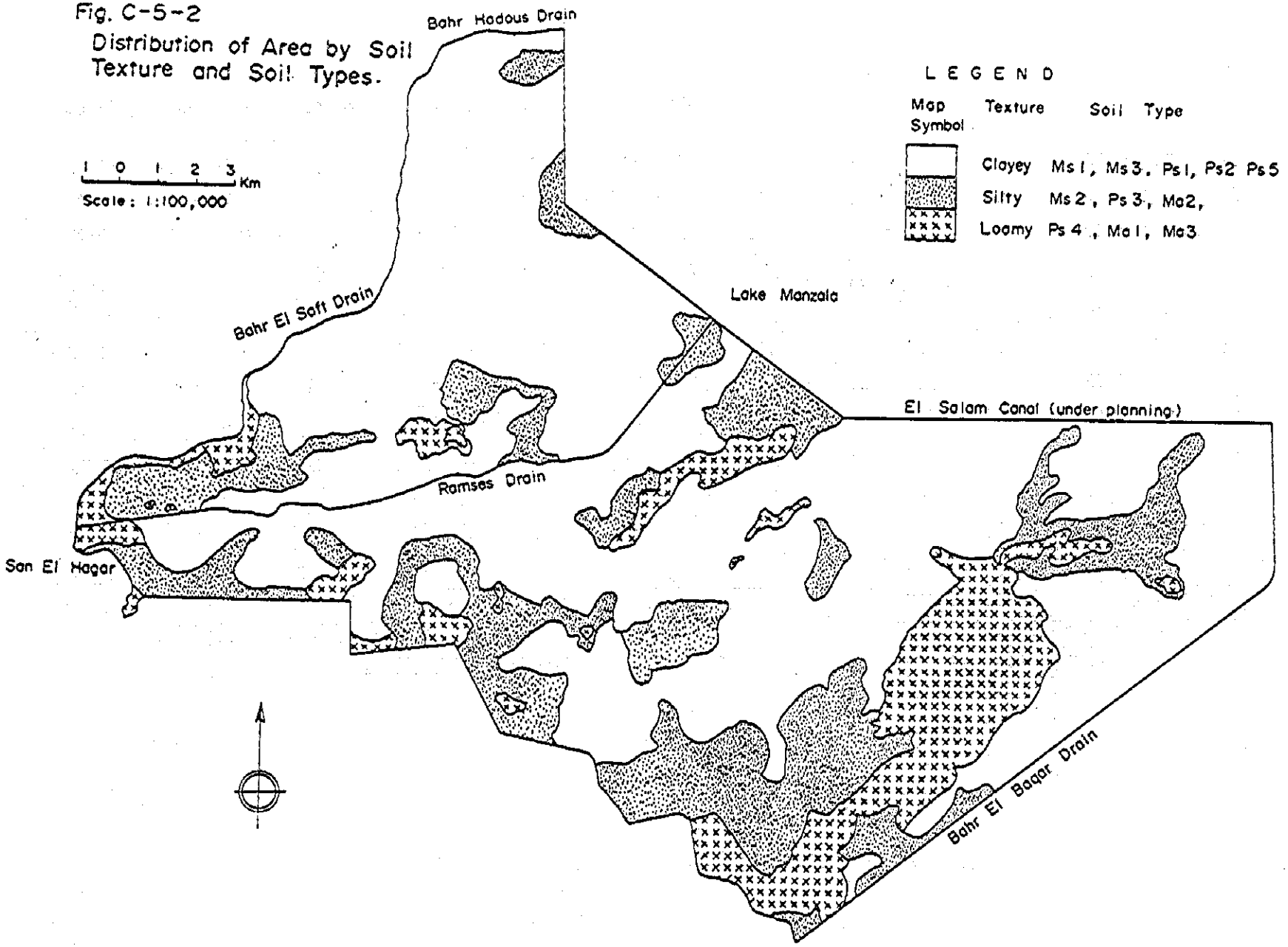


Table C-5-5. Average Chemical Properties of Soil Types (1)

Soil Type	Saturated Soil Paste: Saturation Percentage (SP, %) — Whole Soil Range	Whole Soil Av.	Surface 40 cm Range	Surface 40 cm Av.	pH: Surface 40 cm Range	Surface 40 cm Av.	Saturation Extract: ECe (mmho/cm, 25°C) — Whole Soil Range	Whole Soil Av.	Surface 40 cm Range	Surface 40 cm Av.
Ms 1	60 - 84	75	60 - 84	75	7.8 - 7.8	7.8	19 - 81	43	19 - 81	43
Ms 2	54 - 81	68	55 - 70	63	7.4 - 7.8	7.6	40 - 92	66	53 - 91	72
Ms 3	76 - 88	82	80 - 86	83	7.7 - 8.0	7.9	14 - 46	30	17 - 42	30
Ps 1	51 - 75	63	54 - 69	62	7.3 - 7.6	7.5	40 - 105	73	47 - 95	71
Ps 2	64 - 72	68	64 - 72	68	7.8 - 7.8	7.8	47 - 115	81	50 - 115	83
Ps 3	58 - 76	67	58 - 65	62	7.4 - 7.7	7.6	35 - 93	64	49 - 93	71
Ps 4	41 - 67	54	52 - 67	60	7.5 - 7.6	7.6	60 - 115	88	66 - 115	91
Ps 5	65 - 73	69	66 - 73	70	7.3 - 7.7	7.5	59 - 112	86	61 - 112	87
Ma 1	40 - 58	49	43 - 58	51	7.2 - 7.4	7.3	43 - 121	82	48 - 121	85
Ma 2	50 - 65	58	54 - 64	59	7.4 - 7.7	7.6	36 - 117	77	48 - 116	82
Ma 3	53 - 68	60	54 - 68	63	7.4 - 8.2	7.8	20 - 116	52	20 - 116	52

Note: Range gives figures of lowest and highest average.

Table C-5-6. Average Chemical Properties of Soil Types (2)

Soil Type	Saturation Extract: Ca, me/liter, Surface 40 cm, Range	Ca, me/liter, Surface 40 cm, Av.(a)	Na, me/liter, Surface 40 cm, Range	Na, me/liter, Surface 40 cm, Av.(b)	Ca/Na Ratio a/b (%)	Sodium Adsorption Ratio (SAR)[1/] Range	SAR Av.	CEC[1/] (me per 100g)	Soluble[1/] N (ppm)	Soluble[1/] P (ppm)
Ms 1	75 - 134	98	130 - 1,040	487	20	12 - 61	32	21	38	5.5
Ms 2	110 - 278	194	678 - 1,023	851	23	47 - 60	54	26	59	7.3
MS 3	33 - 165	99	164 - 430	297	33	23 - 34	29	33	42	5.8
Ps 1	198 - 435	317	463 - 947	705	45	34 - 48	41	25	43	4.7
Ps 2	205 - 293	249	650 - 1,477	1,064	23	48 - 86	67	15	24	3.8
Ps 3	137 - 182	160	568 - 1,175	872	18	38 - 71	55	25	53	4.3
Ps 4	143 - 330	237	857 - 1,415	1,136	21	54 - 84	69	18	44	4.3
Ps 5	205 - 350	278	755 - 1,385	1,070	26	44 - 73	59	19	27	5.3
Ma 1	130 - 323	227	439 - 1,490	992	22	32 - 71	52	23	56	4.8
Ma 2	183 - 386	285	455 - 1,290	873	33	29 - 66	48	20	46	5.3
Ma 3	120 - 210	155	190 - 1,860	753	21	21 - 116	53	21	27	6.0

Note: Range gives figures of lowest and highest average.

1/ Surface 40 cm soil

were divided into 5 classes as shown in Table C-5-7. Index reading 23 (10 kg/cm^2) was a critical strength with which no root of the rice plants could penetrate the solum.[18]

(ii) Fertility - cation exchange capacity (CEC) and soluble nitrogen and phosphorus

These items express characteristics correlating soil fertility. CEC is a functional factor in holding plant nutrients. In general 20 - 30 me per 100 g soil are enough to keep the growth in good condition. Soluble nitrogen and phosphorus have been not fully studied to decide their criteria since values much deviate with the different analytical methods. In this case they were classified tentatively.[9]

(iii) Available water - water holding capacity

Amount of available water in the soil can be expressed as half of water holding capacity which also is tentatively estimated to be half of the saturation percentage experimentally obtained. These values have direct relation with clay contents, that is, textural classes. Criteria listed in Table C-5-8 were tentatively made referring to the present range of saturation percentages.

(iv) Sodium removal - Ca++ / Na+ me ratio in saturation extract

This item is adopted as a new attempt to predict risk of deterioration of the soil when it is leached to remove salts contained. Leaching procedure implies that a soil tends to be too alkaline in reaction if soluble Ca^{++} is less than 25% of soluble Na^{+} in terms of me, resulting in clay dispersion and impermeability of substratum. This is the formation of Solonetzs from Solonchaks which is called "solonization".

Criteria for this item was set up tentatively according to the ratios obtained among Soil Types since no research data are available.

Table C-5-7. Criteria of Soil Potentiality Evaluation for Soil Productivity (1)
(Surface 40 cm Soil)

Criteria Value (Limitation)	Workability			CEC (me per 100g soil)	Soluble N (ppm)	Soluble P (ppm)
	Stickiness	Hardness[1/] Index	(kg/cm^2)			
0 (Very good)	Non-sticky	Soft	< 8	(0.98) > 50	> 75	> 11
1 (Good)	Non to slightly sticky	Slighly hard	8 - 12	(1.93) 30 - 50	50 - 75	8 - 11
2 (Moderately good)	Sticky	Hard	12 - 17	(4.04) 20 - 30	25 - 50	5 - 8
3 (Poor)	Sticky to very sticky	Very hard	17 - 23	(10.0) 10 - 20	10 - 25	2 - 5
4 (Very poor)	Very sticky	Extremely hard	> 23	(10.0) < 10	< 10	< 2

Note: Average feature and analytical value are cited; hardness is given with highest index values.

1/ By Yamanaka's Soil Hardness Tester. Index is a reading of resistance of cone when it penetrates the solum.

Table C-5-8. Criteria of Soil Potentiality for Soil Productivity (2)
(Surface 40 cm Soil)

Criteria Value (Limitation)	Water Holding Capacity SP/2 (%)	Sodium Removal Ca(me) / Na(me) Ratio in Saturation Extract (%)	Salinity Damage ECe (mmho/cm, 25°C)
0 (Very good)	> 40	> 45	< 4
1 (Good)	30 - 40	35 - 45	4 - 8
2 (Moderatly good)	20 - 30	25 - 35	8 - 16
3 (Poor)	10 - 20	15 - 25	16 - 32
4 (Very poor)	< 10	< 15	> 32

3) Description of Land Classes Decided

To evaluate the land for soil productivity, some items other than those set up in the foregoing Tables are usually adopted such as grade of gleyzation (Oxido-redox potential), mottlings (Fe and Mn) and depth of available soil.

Among soils existing in the Area, however, these items are not significant to differentiate soil potentiality. Similarly, salinity of the soil expressed as EC or SAR (sodium adsorption ratio) can not be adopted because these values are too high to be evaluated with available common criteria. As a result, potentiality items are selected as shown in Table C-5-9. In the Table each of Soil Types are given with criterion class for each of items and decided to Land Class with sum of all evaluation values.

The Land Classes thus obtained are better than those in the classification for land reclamation. This may mean that soils prevailing in the Area are comparatively good in quality for farming if salinity problem is solved by leaching management. Soil Types, Ms 1, Ps 2, Ps 4 and Ps 5, which were ranked at Class III C, can be improved mainly by fertilization managements together with by improving base status.

A seperate map (MAP C-4) illustrates the result of land classification for land productivity after land reclamation is completed. Table C-5-10 shows extents of each class. Soil Types graded as Class III A cover more than half of the Project Area. Only Ma 1 Type belongs to Class III B because of inferiority in nutritional and soluble base status occupying about 7% of the Area. Levels of production and annual farm returns in Class III may be very low for the first few years after the land reclamation. Agriculture value of the land, however, can be expected to obtain Class II so far as the irrigation and drainage procedure could continue successfully. Ma 3 Type is specifically ranked at IV A for the same reason as mentioned before.

Table C-5-9. Evaluation of Soil Potentiality for Soil Productivity

Soil Type	Workability			CEC	Soluble N	Soluble P	Sodium Removal	Total	Land Class
	Stickiness	Hardness	Av.						
Ms 1	2	1	2	3	3	2	3	13	III C
Ms 2	2	2	2	2	1	2	3	10	III A
Ms 3	4	2	3	1	2	2	2	10	III A
Ps 1	2	1	2	2	2	3	0	9	III A
Ps 2	2	1	2	3	3	3	3	14	III C
Ps 3	1	1	1	2	1	3	3	10	III A
Ps 4	2	2	2	3	2	3	3	13	III C
Ps 5	4	3	3	3	2	2	2	13	III C
Ma 1	2	2	2	2	1	3	3	11	III B
Ma 2	1	2	2	2	2	2	2	10	III A
Ma 3	1	3	2	2	2	2	3	11	IV A[1/]

Note: Refer to Table C-5-7 and C-5-8.

1/ Special evaluation has been made because of their geographical points of view.

Table C-5-10. Areas of Land Classes of Soil Productivity for Irrigated Agriculture in the Project Area

Class	Sub-Class	Suitability	Soil Type	ha	feddan	%
I		Very suitable	-	-	-	-
II		Suitable.	-	-	-	-
III		Medium suitable				
	A	Slight soil management limitations	Ms 2, Ms 3, Ps 1, Ps 3, Ma 2	18,380	43,710	58.5
	B	Moderate management limi.	Ma 1	2,050	4,370	6.5
	C	Severe management limi.	Ms 1, Ps 2, Ps 4, Ps 5	10,310	24,550	32.9
IV		Suitable only under special conditions				
	A	Management limitations	Ma 3	660	1,570	2.1
	B	Reclamation limitations	-	-	-	-
V		To be determined after further detailed studies	-	-	-	-
Total				31,400	74,700	100

C-6. DISCUSSIONS AND RECOMMENDATIONS

The pressing need for increased agricultural production is now pointing to find old lands which were left waste but are newly to be reclaimed. The need is also having an impact on the better quality waters to irrigate the reclaimed lands.

The EL Salam Canal Development Program is a well-timed project aiming to realize the both directions.

Soil survey conducted this time on the South Nosainia Valley Area could present more detailed results of soil classification and land evaluation. In the course of the examination, however, some problems concerning behaviour of salts and use of soil amendment have been brought out on this Solonchak soil area. These will be studied in further survey not only through laboratory analysis but also by field experiments.

Discussions and recommendations based on results from the survey will be described as follows.

C-6-1. Leaching Method

Leaching of soluble salts from the soil is of first paramount importance in the Project Area, paticularly for soils of Ps 2, Ps 4, Ps 5 and Ma 1. It should be noticed that the saturation extracts of the soil samples taken from the Area gave ECe values from 20 to 150 mmhos/cm at 25°C being far beyond the usual status which has been difined of saline-alkali soils.[5] This indicates an extraordinary need of irrigation water on the first stage of leaching and a problem how to use water efficiently under its limited source.

1) Salt Accumulation in Soil

According to the analytical data, salts naturally accumulate in the uppermost layer of the soil, decreasing with the depth from the surface. Soluble ions in the saturation extract are ordered as follows:

Cations: Na^{+} (200 - 2,000 me/ℓ)≫ Ma^{++} > Ca^{++} (50 - 500 me/ℓ) ≫ K^{+}

Anions: Cl^{-} ≫ SO_4^{--} ≫ HCO_3

This shows that NaCl dominates among soluble salts followed by Mg SO_4. Fig. C-6-1 in which soluble sodium is dotted against ECe of the saturation extract gives a tendency that Na^{+} in form of NaCl is more increasing with the increase in ECe. This may prove that salt crust on the top soil consist of nothing but NaCl. Similarly, sodium adsorption ratio which has been considered to express the relative activity of sodium ions in exchange reactions with soil curves upward with the increase in Na^{+} to the surface as is shown in Fig. C-6-2.

Next Fig. C-6-3 was drawn with the data given in APPENDIX C-2 and C-4 (4). In saturation extract, soluble salt content was calculated by SP x ECe x 0.00064 (%). The Figure clearly shows the salt accumulation to the uppermost layer. It is interesting to note that saturation extract contained a half to one forth of soluble salts in the 1:5 soil-water extract. Therefore, the latter extraction would be suitable to know the distribution of salts in the profile. APPENDIX C-4 (6) which was made with this idea shows the results that soluble salts dominate in the upper 40 to 50 cm except for Ms group where salty soil water seemed to move upward very slowly. Total soluble salts are thus summed as is shown in Table C-6-1. Tremendous amounts per ha are recorded ranging from 300 to 1,800 tons over 1 m depth of the profile.

The dominant accumulation of sodium, chlorine and magnesium will further suggest that most of the salts deposited in the Area had been geologically derived from the marine origin.

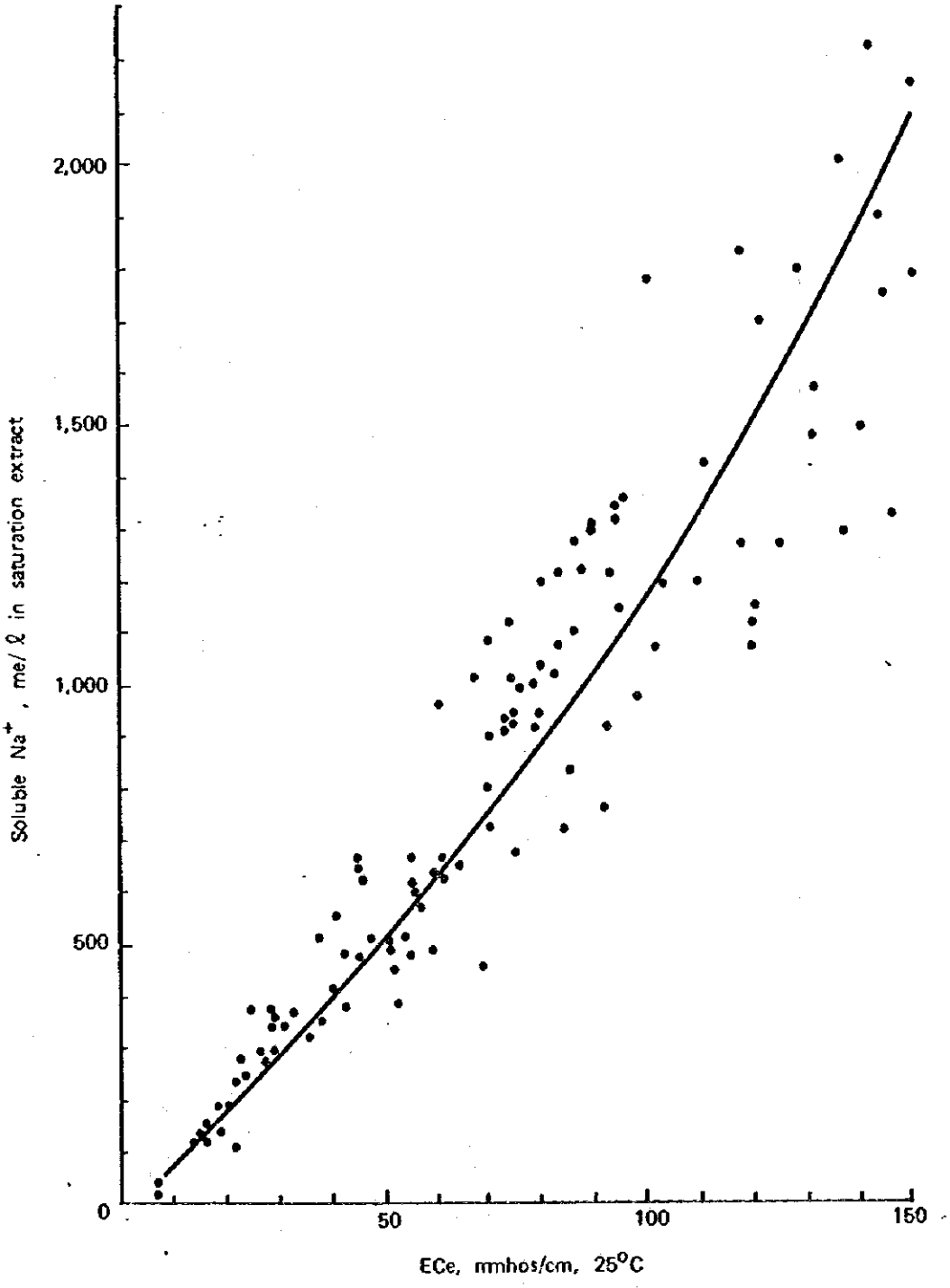


Fig. C-6-1. Relation between Conductivity and Sodium Concentration of the Saturation Extract

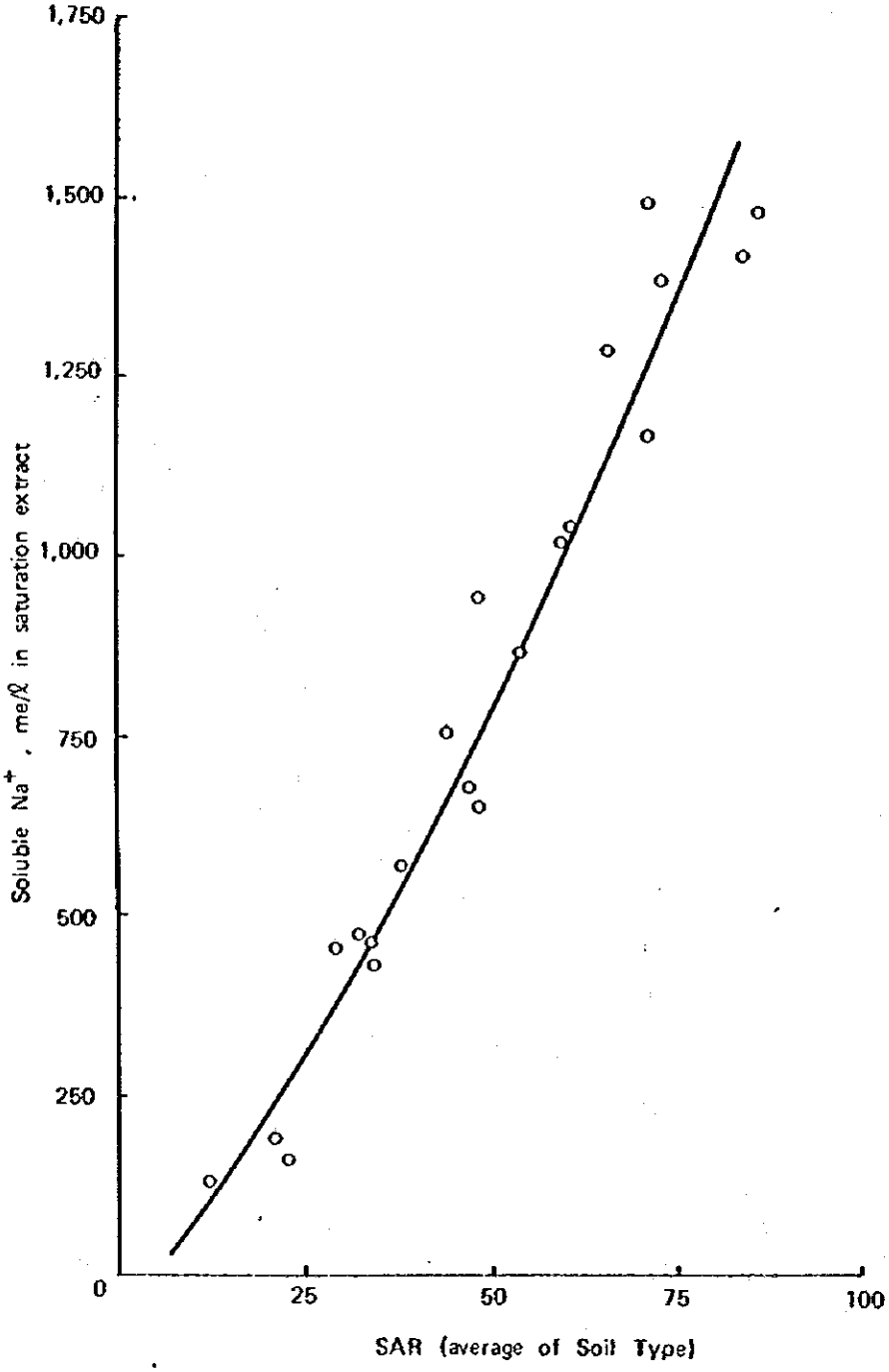


Fig. C-6-2. Relation between Sodium Concentration and SAR of the Saturation Extract

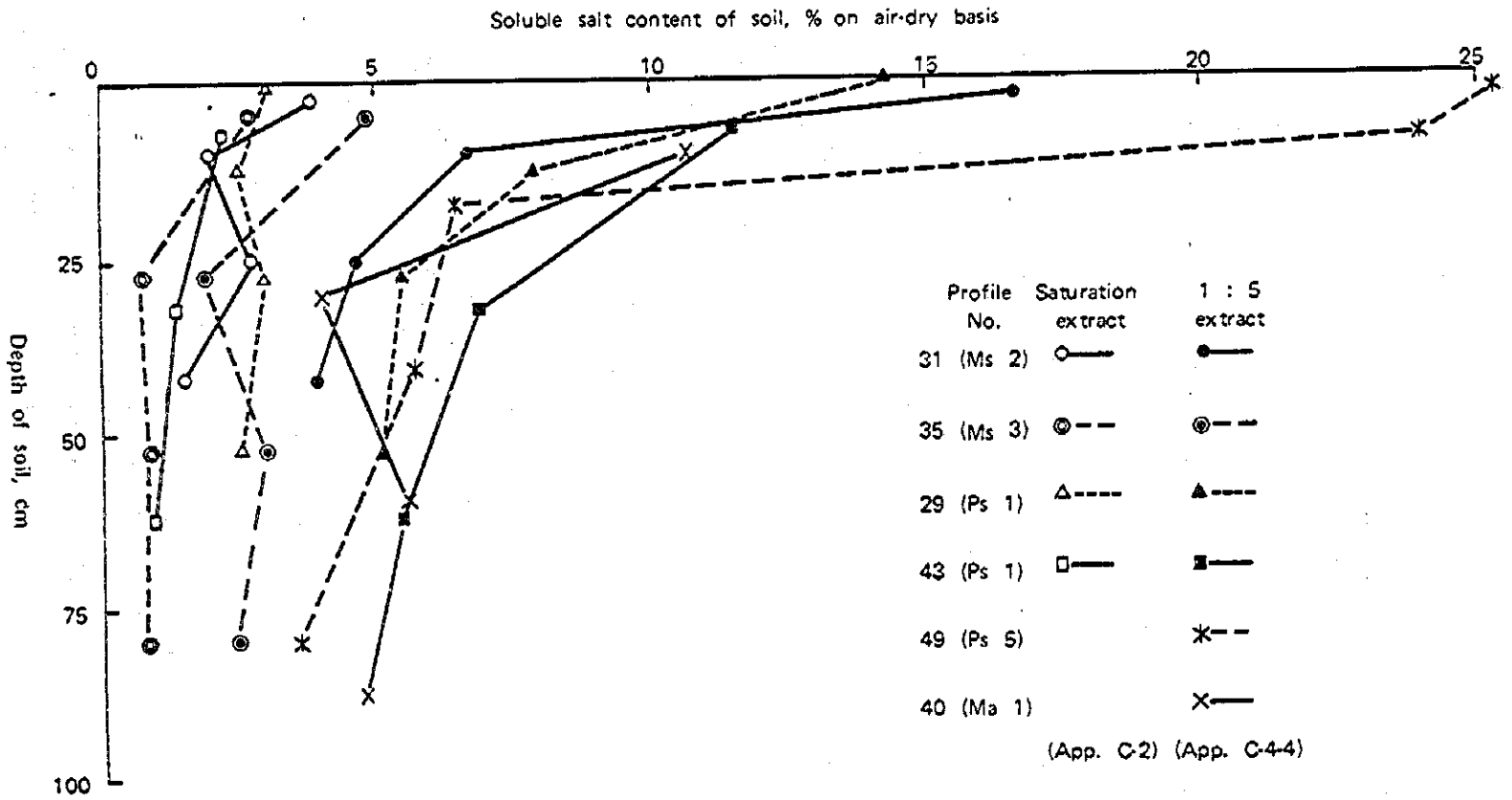


Fig. C-6-3. Soluble Salt Content of Soil with Depth of the Profile as Extimated from Soil Extract Analysis

Table C-6-1. Total Amounts of Soluble Salts Extractable Over 1 m Depth of the Profile

Profile No.		Ms 2 - 31	Ms 3 - 35	Ps 1 - 29	Ps 1 - 43
Soluble Salts	ton/ha	498	295	598	710
	ton/fed.	209	124	251	298

Ps 2 - 45	Ps 5 - 48	Ps 5 - 49	Ma 1 - 40	Ma 1 - 44
1,838	1,348	702	743	1,618
772	566	295	312	680

Remarks: Refer to APPENDIX C-4 (6).

2) Salt Removal and Gypsum

Next concern is about how to leach such saline soils. To investigate salt movement with water, a simple test was conducted by successive extraction. The results are described in APPENDIX C-4 (5) and summarized in Fig. C-6-4 and C-6-5. In Fig. C-6-4 it is easy to understand that after 1 or 2 times extraction at a ratio of 1:5 soil-water EC decreased to below 4 mmhos which is critical point for salinity-sensitive crops. Another visible fact is that clay particles start to disperse at around EC 0.5 mmhos of the extract. This clay dispersion takes place when under lowered salt concentration in the soil solution some of the exchangeable sodium hydrolyze and form sodium hydroxide, resulting in strongly alkaline in reaction. Fig. C-6-5 reveals this increase in pH up to more than 9.5 around which clay disperses.

Comparing the samples used, fine textured subsoils such as 40 - 3 and 40 - 4 (Ma 1) seem to disperse after quick releasing salts into water. These soils lost about 75% of total soluble salts with the first extraction and 90% with the second extraction.

On the other hand, upper soils including wind blown sand (11 - 0) seem to show no apparent clay dispersion and their pH did not in-

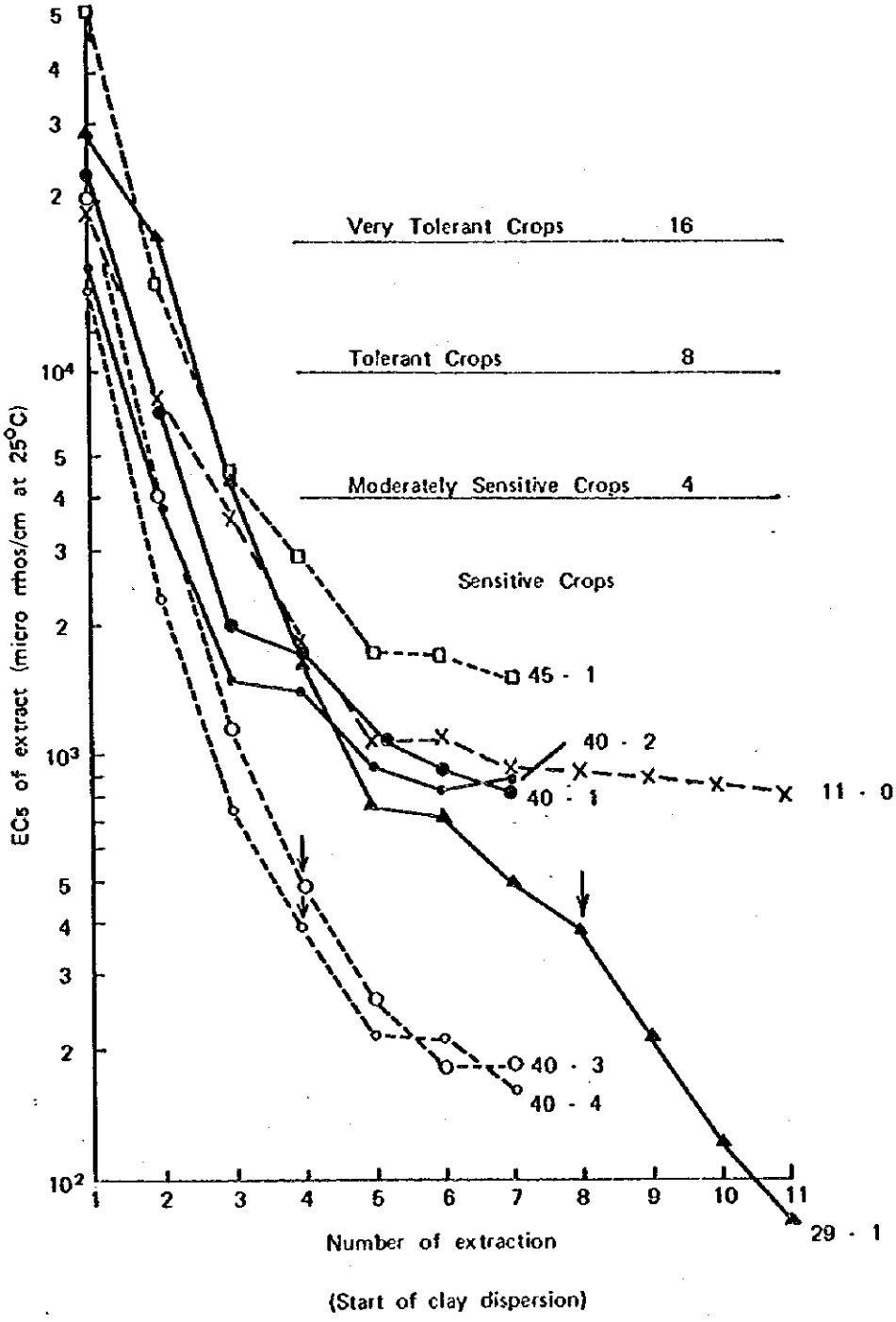


Fig. C-6-4. EC of 1 : 5 Soil Extracts Under Repeated Extraction with Water

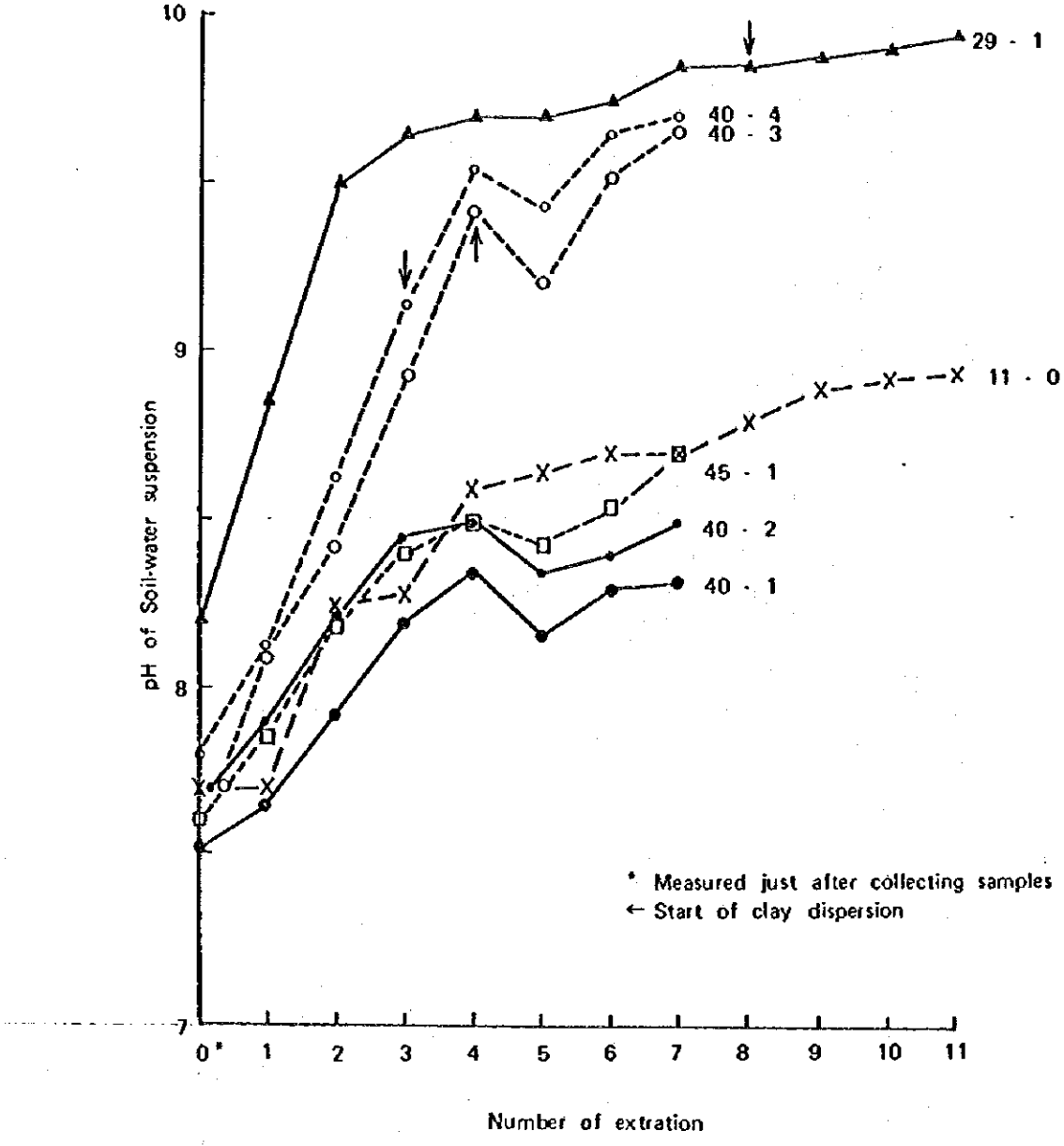


Fig. C-6-5. pH of 1 : 5 Soil-Water Suspensions Under Successive Extration

crease above 9.0, mostly stopping around 8.5. Such difference between two groups appears to suggest exchange reactions in highly saline soils where presence of gypsum may take an important role.

According to the analytical data of APPENDIX C - 4 (1), gypsum contents of the soil deviate over broad range from 0.3 to 17%, only showing a clear tendency that they decrease with depth of the profile. When the soil is leached, calcium dissolved from gypsum will replace exchangeable sodium and accelerate the removal of excess salts, resulting in favorable soil condition. During the leaching gypsum itself is also washed down very rapidly since its solubility increases considerably in the presence of other salts, being more than 2 times in a 10% NaCl solution.[11]

Because of the great deviations in gypsum content of the soils in the Area, it needs to study further on the relation to NaCl removal in the field experiment. As far as the analytical data and profile observations are concerned, however, content of gypsum may be sufficient enough to keep the soil not be dispersed and pH not exceed 8.5 until the leaching period is over.

3) Process of Leaching

Based on the survey results and discussions, some recommendations on the leaching method are described as follows.

(i) Depth of water needed for leaching

Within the soil samples used in Fig. C-6-4, each extract (1:5 soil-water) gives the following ranges of EC:

First extract	12 - 57 (EC, mmhos/cm, 25°C)
Second extract	2 - 16
Third extract	0.7 - 4.5

Macroscopically, after extraction with 5 volumes of water EC in the next extracts decreases to 2 to 16 mmhos which are included in criteria permiting the growth of salinity-tolerant crops.

Third extraction happens to remove salts of comparably low saline soils so excessively that it may cause clay dispersion as mentioned before.

Consequently, it can be suggested that if the surface 40 cm layer corresponding to available depth of soil for the crop growth is to be leached, 2 m depth of water in total should be used by dividing irrigation at more than 10 times, until EC of the saturation extract of the soil becomes below 4 mmhos. Total depth of water can be successfully decreased depending on salinity of the Soil Type and by combining intermittent leaching method.

Care must be taken on the soil impermeability that usually accompanies the excess leaching. Soil structure developed under high salt concentrations is apt to be weak with dispersion of the clay particles that will fill the spaces for water passing as was pointed out already.

(ii) Intermittent leaching

This popular method of leaching is recommended to remove salts more efficiently than the continuous ponding method.[25]

The method aims to keep the soil permeability and to accelerate downward movement of water by forming cracks in the upper soil.

Plowing in the course of drying the field is often a better management for breaking impermeable layer formed between the surface soil and the subsoil.

(iii) Shallow leaching

For quick removal of the salts that were concentrated in the top 10 to 20 cm soil, it shall be proposed to adopt a shallow leaching method, since it may not be wise to drain the leaching water carrying considerable amounts of salt after passing down

through the deep and less saline subsoil layers.

For this method the field must be installed with comparatively shallow open ditches (40 to 50 cm deep) in order to draw discharge through the shallow parts of the soil. Sufficient drying period (1 to 2 months) should be set up between leachings after no water is left on the surface.

The shallow ditches should be more deepened or replaced by subsoil drains as soon as the upper salts are removed and physical ripening of the soil proceeds. Economically best spacing of the ditches must be investigated, too.[23, 24]

(iv) Water quality

In the first stage of leaching the gypsiferous soil might permit the use of an irrigation water having an unfavorably high sodium content.

Table C-6-2 gives a good glance on the status of various kinds of water surrounding the Project Area in terms of electrical conductivity. As is clear from the Table, even active canal water is already stained on the way before reaching the Area, being as high as 1.5 mmhos, followed by drain water having 2.5 mmhos on the average. Considering that almost blind and blind canal water EC range of which increases up to 40 mmhos are somewhat in equilibrium with the soil water, a leaching water even having a conductivity of 10 mmhos may be safely used for the very first process unless any of the lands is subjected to cropping. The possibility is predicted also from the extremely high salt concentrations of the groundwater in the Area. Anyway, EC measurement will afford a better picture of salinity problems in relation to water quality.

Table C-6-2. Average Electrical Conductivity of Water Samples Taken in and Around the Project Area

Water Source	Number of Sites Sampled	pH	EC (mmhos/cm)
Active canal	4	8.03	1.52
Almost blind canal	2	8.10	5.80
Blind canal	3	7.93	22.7
Drain	7	7.77	2.52
Fish pond	2	7.75	9.21
Salty lake	2	7.09	487[1/]
Groundwater	22	6.86	102.7[1/]

Note: Refer to APPENDIX C-4 (2) and C-4 (3) for detailed data.

1/ Simply multiplied of EC determined on the diluted samples.

4) Ground Subsidence Upon Leaching

In general, ground with a shallow water table more or less starts to shrink and sink when the land is drained and dried. Soils of the Project Area have salty crust or puffy salty structure on the top. The density of puffy layer though not yet determined will be less than 0.5. Salt content will range from 5 to 50% of the surface 15 cm and 3 to 10% of the subsoil below 15 cm. Therefore, if these salts are removed by leaching, subsidence of the ground surface is calculated to reach about 10 cm over 1 m depth of the profile.

Such ground subsidence may occur irregularly all over the Area with the progress of land reclamation, and must be in mind in designing the canal and drain arrangement as well as leveling the field plots.

In any event initial reclamation of the Area depends on the performance of leaching by sufficient irrigation and draining of salty water out of the Area successfully without any seepage or contamination to canal water.

C-6-2. Soil Amendments

Amendments to be used for the improvement of saline-alkali soils depend upon the soil charactristics and economic considerations as well. In connection with the above discussion, addition of gypsum at the first stage of reclamation may be questionable; with holding its use is also a matter of research from the standpoints of crack and structure formation in the soil. This is particularly important of the soils of Ps 3, Ps 5 and Ma 1 where many gypsum crystals are observed.

Because of the varying gypsum content among Soil Types, some field trials should be demonstrated to trace the behavior of gypsum when other salts are decreased. (Farmers must be careful about very sharp big crystals especially which were buried in the top soil. The crystals are very dangerous when the soil is mixed up by hand.)

Putting sand or sandy soil on the clayey surface soil, 200 - 400 tons per feddan, is very effective for increasing drainage and workability of the field if its economical transportation is possible. The time of application is recommended to be when the deep cracks are formed upon drying at the final stage of leaching program so that it may be easy to mix with soil by plowing.

C-6-3. Fertilization

How to use fertilizers for the leached soils is also a special problem because many of the plant nutrients are removed from them by leaching. Fertilizer practices generally following leaching should compensate for plant nutrient losses.

In irrigated agriculture nutrient supply for the crops to be cultivated dominantly depends on quality of the irrigation water as well as its quantity.

Nitrogen may be the principle nutrient subject to the lands when they come under cultivation in viewpoints of very small supply

expected from the irrigation, and less content of organic matter and soluble nitrogen in the surface soil. The soluble nitrogen are around 40 ppm on the average of analytical data obtained in the laboratory of SWRI at Giza (see APPENDIX C-4 (1)). This source of nitrogen will be available for a few year at the beginning. Yet after that, continuous application will be necessary.

Adding manure or other forms of organic matter in addition to alternate wetting and drying the land would be a good practice to improve the unfavorable soil structure after leaching. A care must be taken, however, not to accelerate the gleyzation of the subsoils, which tends to develop under the lowered oxido-redox potential.

Phosphate application may be needed although concentration of soluble phosphorus was found to be about 5 ppm on the average according to the present data (see APPENDIX C-2). Physiologically acidic phosphate fertilizers such as super phosphate are recommended because of high alkalinity of the soil.

As for potassium fertilizer there is no urgent aspect of its application since the source can be expected enough from the irrigation water and the soil as well for some periods of cropping after the land reclamation.

C-6-4. Manganese Toxicity

Minor nutrient elements are necessary to be contained in very low concentrations in the soil and irrigation water for supporting plant growth. For example, manganese is sufficient enough if it is contained at the concentration of 0.2 ppm in irrigation waters[6] and 2.5 to 50 mg per 100 g of soil.[20]

Minor elements, however, often behave as a toxicant to plants if they exist in excess; manganese is detrimental to root growth of rice plants and wheat by 50% at the concentration of more than 410 and 220 ppm, respectively in the culture solution.[19]

Soils of the Project Area are mostly characterized of oxidized manganese mottlings and very distinct reaction with a testing reagent throughout the soil profile. Moreover, very high concentrations, approximate 20,000 ppm of active manganese in the soils of south San El Hagar area were already reported.[9] It may be no problem, so far as the oxidative status of the soil is maintained, but once changed to the reduction or acidic in reaction manganese will be active enough to affect the crop production.

Manganese in oxidative form is easily reduced to Mn^{++} and becomes soluble under a weak oxido-redox potential, being accompanied by gleyzation of the soil. Such circumstances will happen to appear when gleyzation progresses under submerged condition of the field for rice.

C-6-5. Future Studies and Experiments

Many problems presented hitherto though not so serious except for salinity will need further studies and experiments on soils of the Area. These would be so effective to solve the problems and extend useful knowledge on soil management and fertility improvement.

Followings are the items to be investigated cooperatively by the governmental Institutes and Experiment Stations concerned:

a) Periodical decrease in salt content of the soil upon leaching in terms of Soil Types and their salinity.

b) Behaviour of gypsum contained in relation to base exchange reaction and structural development.

c) Difference in ion-exchanging activity between transported gypsum crystals and those crystalized in solum.

d) Changes in physical properties of the soil such as permeability and structure stability.

e) Establishment of a shallow leaching method.

f) Fertilyzer experiments on nitrogen, phosphorus and minor elements.

g) Manganese toxicity under reduced condition of the soil.

Overall land use and cropping paterns are not referred here specifically since no decisive inferiority was found in soils of the Area except for a salinity problem. These programs are described in ANNEX D and others of the report. Nevertheless, if maximum efficiency in crop production is to be attained, suitable crops must be grown on the suitable lands as were suggested in this ANNEX.

APPENDIX C

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APPENDIX C - 1

Description of Representative Soil Profiles
Examined in the Project Area

Description of Representative Soil Profiles

Ms 1 - 34

I. Information on the Site

a. Profile No. : 34

b. Soil Name : Clay Swamp Series - Ms 1 Type

c. Date of Examination : 13 September 1980

d. Location : Mochamad Mahach (place name), about 2.5 km south-east of the junction of Bahr El Saft and Hadous Drain.

e. Elevation : 0.2 m

f. Land Form and Slope : Almost flat, land slopes downward gently to west from the pit.

g. Vegetation and Land-use: Uncultivated land, but used for raising fishes. Pit was dug on a small land (5 x 10 m) surrounded fish ponds where many of Cherithe (salt-tolerant plant) grow gregariously in the water. The lands along Saft Drain have been cultivated for 50 years. Rice and cotton were grown there at time of examination.

II. General Information on the Soil

a. Parent Material : Deltaic-transported lagoonally deposited clay of the Nile River Alluvium.

b. Drainage : Very poorly drained

c. Depth of Groundwater : 36 cm below the surface

d. Presence of Surface Stones, Others: None

e. Evidence of Erosion : None at site

III. Profile Description

0 - 0.15 cm	Very thin salt crust covered with a very thin wind-blown sand, silt loam, non-sticky, dark yellowish brown (10YR 4/4).
0 - 15 cm	Dark greish brown (10YR 3/3) moist and brown to dark brown (10YR 4/3) dry, clay; moderate coarse and very coarse platy; sticky, slightly hard (10) moist; no root; clear smooth boundary; pH 7.80 (Sample No.34 - 1).
15 - 36 cm	Dark greish brown (10YR 3/3) moist, clay; moderate medium and coarse subangular blocky; very sticky, slightly hard (13) moist; clear smooth boundary; pH 7.80 (Sample No. 34 - 2). Few gushes at 25 cm and groundwater comes up to 36 cm in one hour. (Sample No.G 18).
36 - 75 cm+	Very dark greish brown (10YR 3/2) moist and brown to dark brown (10YR 4/3) dry, clay; strong medium and coarse blocky with somewhat glossy surface; sticky wet, friable moist, hard (15) moist; gradual smooth boundary; pH 7.84 (Sample No.34 - 3).

Ms 2 - 31

I. Information on the Site

a. Profile No. : 31

b. Soil Name : Clay Swamp Series - Ms 2 Type

c. Date of Examination : 9 September 1980

d. Location : El Mahish (Canal). About 2 km south-east of Bahr El Saft Drain, pit was dug before the fish pond.

e. Elevation : 0.5 m

f. Land Form and Slope : Almost flat, land slopes downward gently to south-east for 2 km from the Drain to the water area.

g. Vegetation and Land-use: Uncultivated. Some small Tarffa and Cherithe plants scatter along the fish pond.

II. General Information on the Soil

a. Parent Material : Deltaic transported and lagoonally deposited medium to fine textured soil of the Nile River Alluvium.

b. Drainage : Poorly drained

c. Depth of Groundwater : 55 cm below the surface

d. Presence of Surface Stones, Others: None

e. Evidence of Erosion : None at site except negligible action of water that will cover the land during winter time only.

III. Profile Description

0 - 0.3 cm	Very thin salt crust covered with a very thin wind-blown silty loam; moist, non-sticky, dark yellowish brown (10YR 4/4).
0 - 5 cm	Moist, fine salt crystalline (NaCl) layer, dark yellowish brown (10YR 4/4); silty loams; structureless (single grain); friable, slightly calcareous; abrupt smooth boundary; pH 7.22 (clay disperses) (Sample No.31 - 1).
5 - 15 cm	Dark greish brown (10YR 3/3) moist, silty clay loam; weak very coarse subangular blocky; slightly sticky, soft (7) moist; few small white gypsum layer (2 - 3 mm thick, 5 - 10 cm long); no root; abrupt smooth boundary; pH 7.52 (clay disperses) (Sample No.31 - 2).
15 - 35 cm	Dark greish brown (10YR 3/3) wet, clay; moderate medium and coarse blocky; sticky, slightly hard (12) wet; aprupt smooth boundary; few gushes at 28 cm; pH 7.70 (Sample No.31 - 2).
35 - 50 cm	Very similar to horizon above but strong blocky, harder (15) wet; groundwater comes up to 55 cm; clear smooth boundary; pH 7.70 (Sample No.31 - 4).
50 - 80 cm+	Almost similar to horizon above but harder (17) wet (Not sampled).

Ms 2 - 37

I. Information on the Site

a. Profile No. : 37

b. Soil Name : Clay Swamp Series - Ms 2 Type

c. Date of Examination : 15 September 1980

d. Location : No name of the site. About 4.5 km north-west of Tell Biluim, pit was made beside the road from the village through some Tells where No.10 profile was examined.

e. Elevation : 0.4 m

f. Land Form and Slope : Almost flat, land slopes downward gently to east and west water areas within 500 m to water edges.

g. Vegetation and Land-use: No vegetation, uncultivated. Some Tarrfa plants are growing on the small dunes scattering close by.

II. General Information on the Soil

a. Parent Material : Deltaic transported and lagoonally deposited heavy textured soil of the Nile River Alluvium.

b. Drainage : Poorly drained

c. Depth of Groundwater : 66 cm below the surface

d. Presence of Surface Stones, Others: None

e. Evidence of Erosion : None at site except negligible action of water that will cover the land during winter time only.

III. Profile Description

0 - 0.3 cm	Very thin salt crust covered with a very thin wind-blown silt loam; non-sticky, dark yellowish brown (10YR 4/4), some small (2 - 3 mm) white-weathered gypsum flakes.
0 - 10 cm	Dark greish brown (10YR 3/3) moist and brown to dark brown (10YR 4/2) dry, clay; weak very coarse platy and blocky; sticky, slightly hard (10) moist; no root; clear smooth boundary; pH 7.86 (Sample No.37 -1).
10 - 19 cm	Dark yellowish brown (10YR 3/4) moist, clay; moderate medium and coarse subangular blocky; very sticky, hard (15) moist; few iron oxides spots on ped surfaces; no root; very few small pieces of brick-like stones; gradual smooth boundary; pH 7.98 (Sample No.37 - 2).
19 - 27 cm	Very similar to horizon above but slightly hard (12) moist and few iron oxides films; clear smooth boundary; pH 8.10 (Sample No. 37 - 3).
27 - 80 cm+	Very dark greish brown (10YR 3/2) moist and brown to dark brown (10YR 4/3) dry, clay; strong medium and coarse blocky with somewhat glossy surface; sticky wet, friable moist, hard (15) moist; pH 8.50 (Sample No. 37 - 4). Few gushes at 40 cm and groundwater comes up to 66 cm in one hour (not sampled).

Ms 3 - 35

I. Information on the Site

a. Profile No. : 35

b. Soil Name : Clay Swamp Series - Ms 3 Type

c. Date of Examination : 14 September 1980

d. Location : Shader Azam (place name), about 2.0 km west of the start point of El Salam Canal from Bahr El Baqar Drain.

e. Elevation : 0.2 m

f. Land Form and Slope : Almost flat, land slopes downward very gently to south-west.

g. Vegetation and Land-use: Under fallow regrowth at time of examination. Grasses include Nyzil (gramineous), phragmites, bulrush and Cherithe. Scattered Tarrfas on the footpath along the small cannals for fish pond that is the main use of the land.

II. General Information on the Soil

a. Parent Material : Deltaic transported and lagoonally deposited clay of the Nile River Alluvium.

b. Drainage : Imperfectly drained

c. Depth of Groundwater : 80 cm below the surface

d. Presence of Surface Stones, Others: None

e. Evidence of Erosion : None at site

III. Profile Description

0 - 0.2 cm	Very thin wind-blown silt loam, dark yellowish brown (10YR 4/4) dry, fine sandy loam; non-sticky.
0 - 10 cm	Brown to dark brown (10YR 4/3) moist, clay; large cracks (10 - 15 cm), strong coarse blocky; slightly sticky moist, slightly hard (12) moist; abundant fine roots; clear smooth boundary; pH 8.20 (Sample No.35 - 1).
10 - 45 cm	Gley horizon (7.5Y 4/1) moist, clay; weak very coarse prismic; very sticky, soft (7) moist; strong Fe^{2+} reaction, few iron oxides mottles and veins; common fine roots; gradual smooth boundary; pH 8.20 (Sample No. 35 - 2).
45 - 60 cm	Almost similar to horizon above but common oxidized spots (10YR 4/3) and few fine roots; clear smooth boundary (Not sampled).
60 - 85 cm	Dark greish brown (10YR 3/3) moist and brown to dark brown (10YR 4/3) dry, clay; moderate medium and coarse subangular blocky; sticky, slightly hard (12) moist; few fine manganese oxides mottles; no root; gradual smooth boundary; pH 8.35 (Sample No.35 - 3). Groundwater comes up at 85 cm depth.
85 - 100 cm+	Very similar to horizon above but silty clay; blocky with somewhat glossy surface and harder (17); pH 8.22 (Sample No.35 - 4).

Ms 3 - 42

I. Information on the Site

a. Profile No. : 42

b. Soil Name : Clay Swamp Series - Ms 3 Type

c. Date of Examination : 18 September 1980

d. Location : Towia. About 1 km south of Bahr El Hadous Drain

e. Elevation : 0.5 m

f. Land Form and Slope : Almost flat, land slopes downward very gently to south.

g. Vegetation and Land-use: Fallow plot of the land where cotton and rice plants are being grown. The pit site is surrounded by phragmites plants.

II. General Information on the Soil

a. Parent Material : Detaic transported and lagoonally deposited clay of the Nile River Alluvium.

b. Drainage : Imperfectly drained

c. Depth of Groundwater : 78 cm below the surface

d. Presence of Surface Stones, Others: None

e. Evidence of Erosion : Almost none at site

III. Profile Description

0 - 1 cm — Thin wind-blown deposit, dark yellowish brown (10YR 3/4) dry, silty clay; non sticky, friable, non-calcareous.

1 - 18 cm — Dark greish brown (10YR 3/3) moist and brown to dark brown (10YR 4/2) dry, clay; strong medium angular blocky; very sticky, slightly hard (12) moist; common iron mottles and veins; no root; abrupt smooth boundary;

	pH 7.90 (clay disperses) (Sample No.42 - 1).
18 - 44 cm	Very similar to horizon above but harder (18); clear smooth boundary; pH 8.42 (Sample No.42- 2).
44 - 78 cm	Greish olive (2.5Y 3/2) moist, clay; weak medium and coarse blocky; very sticky, hard (18); common iron films, slight gley, weak ferrous iron reaction; clear smooth boundary; pH 8.32 (Sample No.42 - 3).
78 - 110 cm+	Almost same as horizon above but more glei status and softer (10); groundwater comes up to 78 cm; pH 8.32 (Sample No.42 - 4) (Sample No. G 20).

Ps 1 - 22

I. Information on the Site

a. Profile No. : 22

b. Soil Name : Port Said Series - Ps 1 Type

c. Date of Examination : 3 September 1980

d. Location : No place name but outside of the government plots. About 2.5 km south of Tell Dibgu, Ramses Drain running between the two, and one salty lake is located 1 km north-west of the site.

e. Elevation : 0.8 m

f. Land Form and Slope : Almost flat, land slopes downward gently to north-west for 1 km.

g. Vegetation and Land-use: No plant, uncultivated

II. General Information on the Soil

a. Parent Material : Deltaic transported and lagoonally deposited (heavy textured) clay of the Nile River Alluvium.

b. Drainage : Imperfectly drained

c. Depth of groundwater : 82 cm below the surface

d. Presence of Surface Stones, Others: None

e. Evidence of Erosion : Almost none at site except negligible wind erosion which may occur during the strong windy season.

III. Profile Description

0 - 0.5 cm	Thin salt crust with a cover of very thin wind brown silt loam, nonsticky, dark yellowish brown (10YR 4/4) dry, slightly calcareous.
0.5 - 11 cm	Dark greish brown (10YR 3/3) moist and brown to dark brown (10YR 4-2) dry, clay; moderate medium subangular blocky; sticky, slightly hard (12) moist; few small (2 - 5 mm) white gypsum crystalline mottles; no root; clear smooth boundary; pH 7.30 (Sample No.22 - 1).
11 - 35 cm	Dark greish brown (10YR 3/3) moist, clay; moderate coarse bangular brocky; very sticky, hard (15) moist; gradual smooth boundary; pH 7.65 (Sample No.22 - 2).
35 - 60 cm	Dark greish brown (10YR 3/3) slightly wet, clay; moderate coarse angular blocky; sticky, hard (18) slightly wet; clear smooth boundary; pH 7.75 (Sample No.22 - 3).
60 - 100 cm+	Dark greish brown (10YR 3/3) slightly wet, light clay; moderate medium angular blocky; very sticky, hard (17) slightly wet; pH 7.50 (Sample No.22 - 4). Groundwater was taken at the depth of 28 cm from the surface (Sample No. G 9).

Ps 1 - 29

I. Information on the Site

a. Profile No. : 29

b. Soil Name : Port Said Series - Ps 1 Type

c. Date of Examination : 8 September 1980

d. Location : Malhit Um Bathy. About 0.5 km north-west of Bahr El Baqar Drain. Beside big water area.

e. Elevation : 0.8 m

f. Land Form and Slope : Almost flat, sloping downward gently to north for 1 to 2 km.

g. Vegetation : None at site but common Cherithe growing on the same land near water.

II. General Information on the Soil

a. Parent Material : Deltaic transported and lagoonally deposited fine textured soil of the Nile River Alluvium.

b. Drainage : Imperfectly drained

c. Depth of Groundwater : 85 cm below the surface

d. Presence of Surface Stones, Others:
A few small (2 - 3 cm) bivalbes

e. Evidence of Erosion : None at site

III. Profile Description

0 - 4 cm — Greish yellow (2.5Y 6/2) to greish olive (2.5Y 5/2) dry, silty loam covered with thin wind-blown deposit (silty clay loam) and salt crust (2 - 3 mm); friable, nonsticky, calcareous; many small crystals (NaCl); abrupt smooth boundary; pH 8.20 (Sample No. 29 - 1).

4 - 21 cm	Dark greish brown (10YR 3/3) moist and brown to dark brown (10YR 4/3) dry, clay; strong very coarse subangular blocky; sticky wet, extremely hard (28) moist; clear smooth boundary; pH 7.92 (Sample No.29 - 2).
21 - 34 cm	Very similar to horizon above but coarse structured, hard (17); clear smooth boundary; pH 7.90 (Sample No.29 - 3).
34 - 72 cm	Almost similar to horizon above; gradual smooth boundary; pH 7.95 (Sample No.29 - 4).
72 - 110 cm+	Very similar to horizon above but very dark greish brown (10YR 3/2) clay; hard (15); few gushes at 75 cm, groundwater comes up to 85 cm (Sample No. G 13).

Ps 2 - 2

I. Information on the Site

a. Profile No. : 2

b. Soil Name : Port Said Series - Ps 2 Type

c. Date of Examination : 26 August 1980

d. Location : Sisi (place name), very close to a salty lake where table salt has been taken by a merchant. 2.5 km north of canal 67 situated near the other side of the lake.

e. Elevation : 0.5 m

f. Land Form and Slope : Almost flat, very gently sloping forward the lake.

g. Vegetation and Land-use: No plant, uncultivated

II. General Information on the Soil

a. Parent Material : Deltaic-transported and lagoonally deposited clay of the Nile River Alluvium.

b. Drainage : Imperfectly drained

c. Depth of Groundwater : 85 cm from the surface

d. Presence of Surface Stones, Others: None

e. Evidence of Erosion : None at Site

III. Profile Description

0 - 2 cm Thick salt crust (NaCl), crucks on the surface like tortoise shell, friable, soft (3) semi-moist, covered with very thin wind-blown silty clay, non-sticky, brown to dark brown (10YR 4/3) dry, non calcareous.

2 - 16 cm	Very dark greish brown (10YR 2/3) moist and (10YR 3/3) dry, clay; moderate medium blocky; sticky, soft (7) moist; few gleyic spots (2 - 3 cm), greish olive (7.5Y 4/2); clear smooth boundary; no root; pH 7.60 (Sample No.2 - 1).
16 - 46 cm	Very dark greish brown (10YR 2/3) moist and greish brown (10YR 5/3) dry; clay; weak to moderate very coarse angular blocky; sticky, soft (7) mottles; very few sandy loam frag- oxides mottles; very few sandy loam frag- ments called "Cofry", interspersed in the layer. Farmers have believed a land having these sandy spots to be very productive (2 - 3 cm long, 5 - 7 mm thick), dark yellowish brown (10YR 4/4) moist, nonsticky, non calcareous; gradual smooth boundary; pH 7.6 (Sample No.2 - 2). Same gushes at the depth of 40 cm.
46 - 70 cm	Very dark greish brown (10YR 2/1) moist, clay; modertate medium blocky; very sticky wet, soft (7) wet; gradual smooth boundary; pH 7.4 (Sample No.2 - 3).
70 - 110cm+	Almost similar to horizon above but slightly hard (12) wet (No sample taken). Groundwater was taken at the depth of 85 cm (Sample No. G 1).

Ps 2 - 12

I. Information on the Site

a. Profile No. : 12

b. Soil Name : Port Said Series - Ps 2 Type

c. Date of Examination : 31 August 1980

d. Location : No place name, close to a salty lake, 2.5 km north-east of Tell Animal.

e. Elevation : 0.8 m

f. Land Form and Slope : Almost flat, land slopes downward gently to east to the salty lake.

g. Vegetation and Land-use: No plant, uncultivated

II. General Information on the Soil

a. Parent Material : Deltaic-transported and lagoonally deposited light and heavy textured soil of the Nile River Alluvium.

b. Drainage : Imperfectly drained

c. Depth of Groundwater : 85 cm from the surface

d. Presence of Surface Stones, Others: None

e. Evidence of Erosion : None at site

III. Profile Description

0 - 2 cm	Thick salt crust (NaCl), crucks on the surface like tortoise shell, very hard almost dry, covered with very thin wind-blown, silty clay, nonsticky, brown to dark brown (10YR 4/4) dry, slightly calcareous.

2 - 10 cm	Almost consolidated salt layer (NaCl lattices), few fine (2 mm) clay aggregates (10YR 3/3) moist; hard, nonsticky; no root; abrupt smooth boundary. (No sample taken).
10 - 25 cm	Slightly gleyic horizon, dark greish olive green (5GY 4/1) moist, silt loam; structureless (massive); nonsticky, soft (5) moist; slight Fe^{2+} reaction; non calcareous; few medium (3 - 4 cm) darker spots (5GY 2/1); clear smooth boundary; pH 7.90 (Sample No.12 - 1).
25 - 45 cm	Dark greish brown (10YR 3/3) wet, clay; structureless (massive); sticky, soft (7) wet; few small (2 - 3 cm) gleyic spots, very slight Fe^{2+} reaction; clear smooth boundary; pH 7.80 (Sample No.12 - 2).
45 - 60 cm	Very dark greish brown (10YR 3/2) moist and brown to dark brown (10YR 4/3) dry, clay; strong medium angular blocky; sticky, slightly hard (12); few small manganese oxides mottles; gradual smooth boundary; pH 7.72 (Sample No.12 - 3). Some gushes at the depth of 50 cm.
60 - 110 cm+	Almost similar to horizon above but glossy structure and more hard (15); pH 7.70 (Sample No.12 - 4).

Ps 3 - 25

I. Information on the Site

a. Profile No. : 25

b. Soil Name : Port Said Series - Ps 3 Type

c. Date of Examination : 4 September 1980

d. Location : No place name, about 1.5 km east of Tell Sanhur.

e. Elevation : 1 m

f. Land Form and Slope : Flat, land slopes downward gently to south-east of the sife for 4 km.

g. Vegetation and Land-use: No plant, uncultivated

II. General Information on the Soil

a. Parent Material : Deltaic-transported and lagoonally deposited clay of the Nile River Alluvium.

b. Drainage : Moderately well drained

c. Depth of Groundwater : 100 cm from the surface

d. Presence of Surface Stones, Others: No stone but common small (2 - 4 mm) white weathered gypsum crystals.

e. Evidence of Erosion : Slight wind erosion only expected in the windy season.

III. Profile Description

0 - 0.5 cm Medium salt crust (NaCl), friable, almost dry; very thin wind-blown sand cover, silty clay, dark yellowish brown (10YR 4/4), non-sticky, non calcareous; clear smooth boundary.

0.5 - 4 cm	Fine needle salt crystal layer, brown to dark brown (10YR 4/3), clay; very friable, structureless (single grain); nonsticky dry; clear smooth boundary; pH 7.27 (Sample No. 25 - 1).
4 - 13 cm	Dark greish brown (10YR 3/3) moist, and brown to dark brown (10YR 4/3) dry; slightly sticky, soft (7) moist; common small (1 - 3 mm) dark brown gypsum crystals horizontally below the ped; very few small (2 - 3 cm long, 7 mm thick) sandy fragments (cofry); clear smooth boundary; pH 7.43 (Sample No.25 - 2).
13 - 30 cm	Dark greish brown (10YR 3/3) moist, clay; moderate very coarse platy and blocky; very sticky, soft (6) moist; few iron oxidised films vertically on the ped; gradual smooth boundary; pH 7.98 (Sample No.25 - 3).
30 - 55 cm	Almost similar to horizon above but silty clay; clear smooth boundary; pH 8.00 (Sample No.25 - 4).
55 - 100 cm+	Very dark greish brown (10YR 3/2) moist, clay; strong medium and coarse angular block with somewhat glossy surface; very sticky, hard (17) moist; pH 7.88 (Sample No.25 - 5). Groundwater showed signs around 1 m depth.

Ps 3 - 26

I. Information on the Site

a. Profile No. : 26

b. Soil Name : Port Said Series - Ps 3 Type

c. Date of Examination : 7 September 1980

d. Location : Arabi Ramsis. About 1 km south of Ramses Drain and 3.5 km north of Tell Sanhur.

e. Elevation : 0.9 m

f. Land Form and Slope : Almost flat, land slopes downward gently to north to the Drain. Pit was dug at the land near fish pond where Toubara or Bouri (official name) fishes are raised.

g. Vegetation and Land-use: No plant at site but many Tarrfa, Cherithe and Hadadi plants along the fish pond edges.

II. General Information of the Soil

a. Parent Material : Deltaic transported deposits (coarse to fine texture) of the Nile River Alluvium.

b. Drainage : Moderately well drained

c. Depth of Groundwater : 85 cm from the surface

d. Presence of Stones, Others: None at site

e. Evidence of Erosion : Slight wind erosion during the windy season from March to May.

III. Profile Description

0 - 1 cm	Fairly thick salt crust covered with very thin wind brown silt loam (10YR 4/4); non-sticky, hard dry, slightly calcareous.
1 - 14 cm	Dark greish brown (10YR 3/3) moist and brown to dark brown (10YR 4/3) dry, silt loam; weak very coarse columnar; friable, sticky moist, soft (8); few small (2 - 3 mm) white crystals and rectangular flakes (2 - 3 cm) of gypsum, non calcareous; clear smooth boundary; pH 7.40 (Sample No.26 - 1).
14 - 38 cm	Dark greish brown (10YR 3/3) moist, silty clay loam; moderate very coarse blocky and columnar; sticky, soft (9) moist; few iron oxides films on the vertical ped; clear smooth boundary; pH 7.50 (Sample No.26 - 2).
38 - 60 cm	Dark greish brown (10YR 3/3) moist, clay; weak medium blocky; very sticky, slightly hard (12) moist; gradual smooth boundary; pH 7.48 (Sample No. 26 - 3).
60 - 100 cm+	Very similar to horizone above but darker color (10YR 3/2), stronger structure with glossy surface, hard (17); pH 7.45 (Sample 26 - 4). Gush comes at the depth of 65 cm and groundwater 85 cm (Sample No.G 10).

Ps 4 - 16

I. Information on the Site

a. Profile No. : 16

b. Soil Name : Port Said Series - Ps 4 Type

c. Date of Examination : 1 September 1980

d. Location : No place name, about 2 km north-west of Bahr El Baqar Drain and 4.5 km south-west of Tell Biluim.

e. Elevation : 1.0 m

f. Land Form and Slope : Almost flat, land slopes downward to south-east to the Drain.

g. Vegetation and Land-use: No plant at the site, uncultivated.

II. General Information on the Soil

a. Parent Material : Deltaic transported deposits (light texture) of the Nile River Alluvium.

b. Drainage : Moderately well drained

c. Depth of Groundwater : 90 cm from the surface

d. Presence of Surface Stones, Others: No stone but many small (2 - 3 cm) rectangular weathered gypsum flakes.

e. Evidence of Erosion : None

III. Profile Description

0 - 0.2 cm Very weak thin crust (NaCl) covered with very thin wind-blown sand (10YR 4/4), silt loam, friable, non calcareous; clear smooth boundary.

0.2 - 6 cm	Puffy salty layer, dark yellowish b.(10YR 4/4) dry; clay; structureless (single grain) with many small salt needle crystals (NaCl); friable, soft (0) dry; clear smooth boundary; pH 7.25 (Sample No.16 - 1).
6 - 25 cm	Dark greish brown (10YR 3/3) slightly moist and brown to dark brown (10YR 4/3) dry; moderate medium subangular blocky; sticky, slightly hard (10) moist; few small (2 - 3 cm) fresh gypsum flakes; clear smooth boundary; pH 7.38 (Sample No.16 - 2).
25 - 40 cm	Almost similar to horizon above but silt loam; moderate coarse blocky and more frequent gypsum flakes; clear smooth boundary; pH 7.60 (Sample No.16 - 3).
40 - 55 cm	Dark greish brown (10YR 3/3) wet, silt loam; weak coarse angular blocky; sticky, soft (7) wet; few iron and manganese oxides spots; gradual smooth boundary; pH 7.60 (Sample No. 16 - 4).
55 - 100 cm+	Dark greish brown (10YR 3/3) slightly wet, clay, weak very coarse blocky; sticky, slightly hard (10); few small manganese oxides spots; pH 7.50 (No sample taken). Groundwater came up at 85 cm depth. (Sample No.G 5).

Ps 5 - 1

I. Information on the Site

a. Profile No. : 1

b. Soil Name : Port Said Series - Ps 5 Type

c. Date of Examination : 26 August 1980

d. Location : No place name, about 700 m east of salty lake where table salt is being taken commercially and 5 km north-west of Bahr El Baqar Drain.

e. Elevation : 1.0 m

f. Land Form and Slope : Almost flat, land slopes downward to west to the lake.

g. Vegetation and Land-use: No plant at site but small Tarffa trees on near by small low (0.5 - 1 m high) dunes.

II. General Information on the Soil

a. Parent Material : Deltaic transported and lagoonally deposited clay of the Nile River Alluvium.

b. Drainage : Moderately well drained

c. Depth of Groundwater : 120 cm from the surface

d. Presence of Stones, Others: No stone at site. Many small (1 - 2 cm) rectangular gypsum crystals.

e. Evidence of Erosion : None at site

III. Profile Description

0 - 1 cm	Wind-brown sandy layer, dark yellowsh brown (10YR 4/4) dry, silt loam; structureless (single grains); non-sticky, loose dry; abrupt smooth boundary.
1 - 6 cm	Thick puffy salty (NaCl) layer, brown to dark brown (10YR 4/3) slightly moist, clay; structureless (single grain) with many small (1 - 1.5 cm) salt needle crystals (NaCl); slightly sticky moist, friable (0); abrupt smooth boundary; pH 7.15 (Sample No.1 - 1).
6 - 25 cm	Very dark greish brown (10YR 3/2) slightly moist, dark greish brown (10YR 3/3) dry, clay; moderate medium blocky; sticky, hard (15) moist; few small (2 - 3 mm) white gypsum crystals; clear smooth boundary; pH 7.40 (Sample No.1 - 2).
25 - 65 cm	Almost similar to horizon above but very hard (22) moist; gradual smooth boundary; pH 7.60 (Sample No.1 - 3).
65 - 110 cm	Almost similar to horizon above but silty clay; almost no gypsum crystal and very hard (23) moist; gradual smooth boundary; pH 8.10 (Sample No.1 - 4).
110 - 140 cm+	Very dark greish brown (10YR 3/2) moist to west, clay; strong coarse blocky; sticky, very hard (23) moist; few small rectangular gypsum crystals (No sample taken). Groundwater comes out at the depth of 120 cm.

Ma 1 - 17

I. Information on the Site

a. Profile No. : 17

b. Soil Name : Manzala Series - Ma 1 Type

c. Date of Examination : 2 September 1980

d. Location : Housein No.6, near pump station, about 1 km north of Tarouti No.1 village and 2 km south of Ramses Drain. Site is inside of Government plots.

e. Elevation : 1.2 m

f. Land Form and Slope : Almost flat, land slopes downward to south-east by 2 km.

g. Vegetation and Land-use: No plant on the site but few Cherithe and Hadadi plants along the ditches. Rice was being grown on nearby field on the village side.

II. General Information on the Soil

a. Parent Material : Deltaic transported and lagoonally deposited light textured soil of the Nile River Alluvium.

b. Drainage : Moderately well drained

c. Depth of Groundwater : More than 120 m from the surface

d. Presence of Stones, Others: None but common small (1 - 2 cm) rectangular gypsum flakes.

e. Evidence of Erosion : Slight wind erosion estimated only in windy season.

III. Profile Description

0 - 2 cm	Wind-brown sand, dark yellowish b. (10YR 4/4) dry, silt loam, friable, structureless (single grain), very slightly calcareous; abrupt smooth boundary (puffy).
2 - 7 cm	Thick puffy salty layer, dark greish brown (10YR 3/3) almost dry and brown to dark brown (10YR 4/3) dry, loam; strong fine granular with many small (1 - 1.5 cm) salt needle crystals (NaCl); sticky, very hard (20) clear smooth boundary; pH 7.05 (Sample No.17 - 1).
7 - 19 cm	Dark greish brown (10YR 3/3) slightly moist, silty clay; strong medium blocky; sticky, hard (17) moist few small (2 mm) sodium chloride crystals, clear smooth boundary; pH 7.20 (Sample No.17 - 2).
19 - 47 cm	Dark greish brown (10YR 3/3) moist, silt loam; strong medium blocky; sticky, very hard (19) moist; few sandy spots (cofry); gradual smooth boundary; pH 7.42 (Sample No.17 - 3).
47 - 80 cm	Almost similar to horizon above but very hard (21) moist; clear smooth boundary; pH 7.60 (Sample No.17 - 4).
80 - 120 cm+	Dark greish brown (10YR 3/3) moist, silt loam; strong medium blocky; sticky, very hard (22); pH 7.80 (Sample No.17 - 5). Groundwater came out at the depth of 120 cm.

Ma 1 - 20

I. Information on the Site

a. Profile No. : 20

b. Soil Name : Manzala Series - Ma 1 Type

c. Date of Examination : 3 September 1980

d. Location : Tarouti End, about 1 km east of Tarouti No. 2 village and 3 km south of Ramses Drain.

e. Elevation : 1.3 m

f. Land Form and Slope : Almost flat, land slopes downward to south-west.

g. Vegetation and Land-use: No plant at site but some Tarffa trees and Phragmites plants along the ditches. Uncultivated Government plots.

II. General Information on the Soil

a. Parent Material : Deltaic transported deposits (medium texture) of the Nile River Alluvium.

b. Drainage : Moderately well drained

c. Depth of Groundwater : More than 120 cm from the surface

d. Presence of Surface Stones, Others: None at site

e. Evidence of Erosion : None at site

III. Profile Description

0 - 1 cm Wind-brown sand, brown to dark brown (10YR 4/3) slightly moist; silty clay loam; structureless (single grain); friable, slightly calcareous; abrupt smooth boundary.

1 - 7 cm	Thick puffy salty layer, dark greish brown (10YR 3/3) moist, silty clay; strong fine angular blocky with many small salt crystals (NaCl); sticky, friable (5) moist; clear smooth boundary; pH 7.10 (Sample No. 20 - 1).
7 - 17 cm	Dark greish brown (10YR 3/3) moist, brown to dark brown (10YR 4/3) dry, silty clay loam; moderate medium and coarse blocky and platy; sticky, very hard (21) moist; gradual smooth boundary; pH 7.40 (Sample No.20 - 2).
17 - 40 cm	Very similar to horizon above but few small (3 mm) white gypsum crystals; clear smooth boundary; pH 7.60 (Sample No.20 - 3).
40 - 60 cm	Dark greish brown (10YR 3/3) moist, silty clay loam; weak very coarse blocky; sticky, hard (15); gradual smooth boundary; pH 7.75 (Sample No.20 - 4).
60 - 100 cm+	Almost similar to horizon above but slightly hard (13) moist; pH 7.80 (Sample No.20 - 5). Gush water comes out at the depth of 80 cm and groundwater, 120 cm (Sample No.G 8).

Ma 2 - 4

I. Information on the Site

a. Profile No. : 4

b. Soil Name : Manzala Series - Ma 2 Type

c. Date of Examination : 27 August 1980

d. Location : Taimor Hanoon (place name), about 1 km north of Canal 67 and 1 km south-east of a salty lake where table salt is being taken.

e. Elevation : 1.5 m

f. Land Form and Slope : Almost flat, land slopes downward gently to north-west to the salty lake.

g. Vegetation and Land-use: No plant at site but some Tarffa plants on the scattered clay dunes within the land which was plotted per feddan and now laid fallow after once leached by the Government.

II. General Information on the Soil

a. Parent Material : Deltaic-transported and lagoonally deposited heavy textured soil of the Nile River Alluvium.

b. Drainage : Moderately well drained

c. Depth of Groundwater : More than 120 cm from the surface

d. Presence of Surface Stones, Others: No stone but common small (1 - 3 cm) flat weathered gypsum flakes.

e. Evidence of Erosion : Slight wind erosion only expected in the windy season.

III. Profile Description

0 - 2 cm	Dark yellowish brown (10YR 3/4) dry, wind-blown sand, silt loam; structureless (single grain); very friable; common gypsum flakes; abrupt smooth boundary.
2 - 6 cm	Thick salt crust (NaCl) layer on the top (1 cm), very dark greish brown (10YR 2/3) dry, clay; moderate coarse platy; friable dry, very hard (20) dry; common small (2 - 3 m) dark brown gypsum crystals under the salt crust; clear smooth boundary; pH 7.40 (Sample No.4 - 1).
6 - 27 cm	Very dark greish brown (10YR 3/2) slight moist and brown to dark brown (10YR 4/3) dry, silty clay; weak very coarse blocky and platy; sticky, very hard (23) slight moist; few fine (2 - 3 mm) gypsum crystals; clear smooth boundary; pH 7.70 (Sample No. 4 - 2).
27 - 45 cm	Almost similar to horizon above but less hard (18) and common small dark brown gypsum crystals; clear smooth boundary; pH 8.2 (Sample No.4 - 3).
45 - 140 cm+	Very similar to horizon above but almost no gypsum crystal; pH 8.13 (Sample No.4 - 4).

Ma 2 - 23

I. Information on the Site

a. Profile No. : 23

b. Soil Name : Manzala Series - Ma 2 Type

c. Date of Examination : 4 September 1980

d. Location : Taimor village end, about 800 m south of Tell Sanhur.

e. Elevation : 2.0 m

f. Land Form and Slope : Almost flat, land slopes downward to east for 2 km.

g. Vegetation and Land-use: No plant at site, few Tarffa and Hadadi plants growing nearby, uncultivated.

II. General Information on the Soil

a. Parent Material : Deltaic transported deposits (fine texture) of the Nile River Alluvium.

b. Drainage : Well drained

c. Depth of Groundwater : Unknown, but almost certainly between 120 and 150 cm.

d. Presence of Stones, Others: No stone

e. Evidence of Erosion : None at site

III. Profile Description

0 - 0.2 cm Very thin salt crust covered with very thin wind blown sand (10YR 4/4) dry, silty clay loam; structureless, slightly sticky wet; abrupt smooth boundary.

0.2 - 4 cm	Puffy salty layer, dark yellowish brown (10YR 4/4) dry, silty clay loam; structureless with small salt needle crystals (NaCl); friable, non calcaleous; clear smooth boundary (Not sampled).
4 - 13 cm	Dark greish brown (10YR 3/3) almost dry, clay; strong medium angular blocky; slightly sticky, soft (7) moist; few salt (NaCl) crystals and small (1 - 3 cm) gypsum rectangular crystals (transported); clear smooth boundary; pH 7.05 (Sample No.23 - 2).
13 - 30 cm	Dark greish brown (10YR 3/3) almost dry, clay; moderate to strong coarse brocky; slightly sticky, very hard (20); small (2 - 3 cm long, 1 cm thick) sand spots (cofry); gradual smooth boundary; pH 7.50 (Sample No.23 - 2).
30 - 46 cm	Almost similar to horizon above but no cofry, and few manganese oxides veins; clear smooth boundary; pH 7.65 (Sample No.23 - 3).
46 - 62 cm	Very dark gresih brown (10YR 3/2) slightly moist, clay; strong coarse blocky; sticky, very hard (23); few manganese oxides spots; gradual smooth boundary; pH 7.55 (Sample No. 23 - 4).
62 - 110 cm+	Almost similar to horizon above but somewhat glossy structure surface; pH 7.75 (Sample No.23 - 5).

Ma 3 - 10

I. Information on the Site

a. Profile No. : 10

b. Soil Name : Manzala Series - Ma 3 Type

c. Date of Examination : 30 August 1980

d. Location : No place name, about 4 km north-west of Bahr El Baqar Drain.

e. Elevation : 4.0 m

f. Land Form and Slope : Gently sloping (2 - 3%), downward to east for 200 m.

g. Vegetation and Land-use: No plant at site but some Cherithe plants grow vigorously on the small clay dunes (1 - 2 m high), uncultivated.

II. General Information on the Soil

a. Parent Material : Deltaic transported deposits (coarse texture) of the Nile River Alluvium.

b. Drainage : Well drained

c. Depth of Groundwater : Unknown but almost certainly more than 2 m, no influence on profile.

d. Presence of Stones, Others: No stone but few small (2 - 4 cm) spiral shells.

e. Evidence of Erosion : Wind erosion only in windy season

III. Profile Description

0 - 8 cm Wind blown sand surface (2 cm) and puffy salty layer, dark yellowish brown (10YR 3/4), silty loam; friable, non sticky dry, non calcareous; abrupt smooth boundary (Not sampled).

8 - 16 cm	Very dark greish brown (10YR 2/2) dry, silt loam; strong medium platy and blocky; friable, extremely hard (26); fine salt crystals (NaCl) at upper portion; clear smooth boundary; pH 7.38 (Sample No.10 - 1).
16 - 27 cm	Very dark yellowish brown (10YR 2/3) slightly moist, silty clay loam; moderate to strong medium blocky; sticky, very hard (24) moist; clear smooth boundary; pH 7.70 (Sample No. 10 - 2).
27 - 55 cm	Almost similar to horizon above but few manganese oxides spots; gradual smooth boundary; pH 8.18 (Sample No.10 - 3).
55 - 100 cm+	Almost similar to horizon above but slightly less hard (22); pH 8.20 (Sample No.10 - 4).

Ma 3 - 54

I. Information on the Site

a. Profile No. : 54

b. Soil Name : Manzala Series - Ma 3 Type

c. Date of Examination : 4 October 1980

d. Location : Foot of Tell Dibqu, about 400 m south-west of the top. Pit was dug on the slope.

e. Elevation : 3.5 m

f. Land Form and Slope : Slightly undulating (4 - 10%), sloping downward to west for 500 m.

g. Vegetation and Land-Use : Some Tarffas and Phragmites growing at site, uncultivated.

II. General Information on the Soil

a. Parent Material : Deltaic transported deposited coarse-texture soil of the Nile River Alluvium.

b. Drainage : Well drained

c. Depth of Groundwater : Unknown, but almost certainly more than 150 cm from the surface.

d. Presence of Stones, Others: None at site

e. Evidence of Erosion : Moderate wind erosion estimated only in windy season.

III. Profile Description

0 - 3 cm : Wind blown sand, yellowish brown (10YR 3/6) dry, silt loam; friable, structure-less; very slightly calcareous; abrupt smooth boundary (Not sampled).

3 - 22 cm	Puffy salty layer, dark greish brown (10YR 3/3) slightly moist, silty clay loam; structureless (single grain); friable moist, slightly sticky wet, soft (4); many NaCl needle crystals (1 - 2.5 cm); few small white gypsum crystals; few roots of Tarrfa and Phragmites; clear smooth boundary (Not smapled).
22 - 50 cm	Dark greish brown (10YR 3/3) slightly moist, silty clay loam; weak coarse blocky; slightly sticky moist, hard (14) moist; few small white gypsum crystals; few roots of Tarrfa and Phragmites; gradual smooth boundary (Not sampled).
50 - 78 cm	Almost similar to horizon above but slightly more clayey, very sticky, less harder (12), no root; clear smooth boundary (Not sampled).
78 - 100 cm	Almost similar to horizon above but less hard (10); few decayed Phragmites roots in which common small gypsum crystals exist; gradual smooth boundary (Not sampled).
100 - 140 cm+	Almost similar to horizon above but dark yellowish brown (10YR 3/4); weak very coarse blocky; soft (7), no root (Not sampled).

APPENDIX C-2

Physical and Chemical Analysis Data of Soils Samples for Soil Series and Types in the Project Area

1. Clay Swamp Series - Ms 1 Type

Profile No.34

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0-15*	60	8.1	81.4	1.3	1,290	334	134	450	1,040	1.4	61	2.5
2	15-36	84	8.3	19.2	1.8	230	139	75	165	130	0.6	12	1.0
3	36-80	81	8.2	28.7	1.8	381	193	85	200	290	0.6	24	0.4

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture
1	0-15*	50	35	15	C
2	15-36	65	30	5	C
3	36-80	70	25	5	C

Note: * Wind blown deposit and salt crust were excluded.

2. Clay Swamp Series - Ms 2 Type

Profile No.31

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3--	Cl-	SO_4--	Cations Ca++	Mg++	Na+	K+	SAR	$CaCO_3$ (%)
1	0- 5	40	8.4	146.6	0.9	2,210	622	583	920	1,328	2.2	48	0.7
2	5-15	35	8.4	87.9	0.8	1,140	516	265	665	725	1.3	34	2.5
3	15-35	70	8.0	63.5	0.9	930	337	180	424	662	1.2	38	1.6
4	35-50	83	8.0	28.6	2.6	388	180	74	121	375	0.6	38	1.8

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture
1	0- 5	25	70	5	SiL
2	5-15	35	60	5	SiL
3	15-35	65	30	5	C
4	35-50	75	20	5	C

Profile No.36

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0-12*	64	7.7	28.7	2.4	350	218	60	230	280	0.6	23	0.7
2	12-40	62	8.0	24.9	3.3	365	127	37	83	375	0.5	48	0.8
3	40-57	82	8.0	31.6	2.0	490	139	92	196	342	0.6	29	2.5
4	57-90	83	8.1	21.1	2.4	220	200	83	147	192	0.4	18	6.9

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture
1	0-12*	45	40	15	SiC
2	12-40	45	50	5	SiC
3	40-57	65	20	15	C
4	57-90	60	25	15	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.37

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0-10*	77	7.2	95.8	1.5	1,499	414	192	356	1,365	1.1	83	1.4
2	10-19	64	7.8	69.9	1.5	1,078	320	114	192	1,092	0.9	85	1.5

Mechanical Analysis

Sample No.	Depth (cm)	Caly (%)	Silt (%)	Sand (%)	Texture
1		50	35	15	C
2		55	30	15	C

Note: * Wind blown deposit and salt crust were excluded.

3. Clay Swamp Series - Ms 3 Type

Profile No.28

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1		80	7.9	27.3	3.3	392	151	85	110	350	0.5	36	3.9
2		75	7.9	36.7	2.2	588	144	95	155	483	0.6	43	0.6
3		78	7.8	56.6	2.2	790	340	368	202	561	0.8	33	1.8
4		74	7.8	70.5	3.3	1,065	342	425	245	739	1.0	40	0.3

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1		50	30	20	C
2		35	25	40	CL
3		50	15	35	C
4		30	45	25	CL

Note: * Wind blown deposit and salt crust were excluded.

Profile No.30

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0- 8	86	8.2	14.7	3.2	148	62	17	56	140	0.4	23	3.1
2	8-17	91	8.2	35.2	2.6	490	210	31	201	470	0.6	44	3.8
3	17-37	93	8.2	7.3	3.2	42	28	15	32	26	0.2	5.3	2.3
4	37-78	91	8.2	7.3	2.6	44	27	9.5	24	40	0.2	9.8	2.4

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 8	60	25	15	C
2	8-17	65	20	15	C
3	17-37	65	20	15	C
4	37-78	55	30	15	C

Profile No.35

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0- 10	85	7.7	50.8	3.3	687	326	185	335	495	0.9	31	7.5
2	10- 45	72	7.3	15.3	3.0	137	80	18	72	130	0.3	19	1.1
3	60- 85	81	7.8	16.3	3.2	183	81	23	84	160	0.3	22	0.5
4	85-100	60	7.8	22	3.0	321	120	18	112	310	0.4	39	0.3

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 10	75	20	5	C
2	10- 45	75	20	5	C
3	60- 85	75	20	5	C
4	85-100	50	45	5	SiC

Profile No.42

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Cl-	SO_4^{--}	Cations Ca++	Mg++	Na+	K+	SAR	$CaCO_3$ (%)
1	1- 18	87	7.9	24.9	1.3	294	163	74	187	197	0.5	17	1.9
2	18- 44	84	8.4	8.6	2.2	50	33	12	36	37	0.3	7.6	1.4
3	44- 78	84	8.3	6.7	2.2	39	26	10	29	28	0.3	6.3	1.3
4	78-110	93	8.3	6.7	1.3	42	24	17	20	30	0.3	6.9	1.4

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	1- 18	85	10	5	C
2	18- 44	80	15	5	C
3	44- 78	75	20	5	C
4	78-110	80	15	5	C

4. Port Said Series - Ps 1 Type

Profile No.5

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0- 8	57	7.2	147	2.4	2,361	589	905	745	1,300	2.2	45	0.4
2	8- 42	67	7.4	85.5	2.2	1,364	345	373	627	710	1.2	32	0.8
3	42- 65	74	7.7	80.8	1.5	1,217	393	263	348	1,000	1.0	57	0.2
4	65-100	67	7.8	66.5	1.0	1,079	431	201	379	930	0.7	55	1.5

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 8	80	10	10	C
2	8- 42	60	30	10	C
3	42- 65	49	34	7	C
4	65-100	55	38	7	C

Profile No.14

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3--	Cl-	SO_4--	Cations Ca++	Mg++	Na+	K+	SAR	$CaCO_3$ (%)
1	4- 15*	73	7.3	55.8	3.3	925	193	218	202	700	1.5	48	0.8
2	15- 28	83	7.2	65.0	2.4	926	374	250	250	800	1.5	51	0.4
3	28- 63	58	7.6	55.8	2.4	735	376	150	152	810	1.4	66	1.6
4	63-100	61	7.3	93.0	1.3	1,290	571	374	561	925	1.9	43	0.6

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	4- 15*	87	3	10	C
2	15- 28	79	3	19	C
3	28- 63	74	11	15	C
4	63-100	43	33	24	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.18

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0- 9*	49	7.6	119.6	2.6	1,579	803	229	1,071	1,080	2.0	42	0.6
2	9- 20	65	7.6	50.6	1.3	731	281	109	413	490	1.0	30	0.8
3	20- 45	61	7.6	64.4	1.5	927	362	218	292	780	1.2	49	1.1
4	45- 80	54	7.6	27.6	1.7	400	152	56	141	355	0.6	36	1.7
5	80-110	70	7.7	50.6	2.2	729	280	109	161	740	1.0	64	2.4

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 9*	30	56	14	SiCL
2	9- 20	64	22	14	C
3	20- 45	52	32	16	C
4	45- 80	46	38	16	C
5	80-110	58	30	12	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.22

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0.5-11*	50	6.9	36.9	2.0	520	216	169	261	307	0.6	30	0.4
2	11-35	65	7.7	56.4	2.2	880	245	191	460	475	1.2	26	1.7
3	35-60	60	7.8	32.3	2.2	633	211	159	246	440	0.8	31	1.5
4	60-90	64	7.7	51.7	2.6	880	292	272	346	555	1.7	32	1.1

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0.5-11*	57	33	10	C
2	11-35	45	39	16	C
3	35-60	48	35	17	C
4	60-90	58	26	16	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.27

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	2- 15*	45	7.6	131.6	1.9	2,050	576	495	551	1,580	2.1	69	0.5
2	15- 34	48	7.6	117.5	1.2	1,944	405	590	473	1,285	2.0	56	1.0
3	34- 63	68	7.6	61.1	1.1	878	339	130	317	770	0.8	52	1.1
4	63-100	59	7.7	33.0	1.2	509	151	115	145	400	0.5	35	0.8

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	2- 15*	35	50	15	SiCL
2	15- 34	30	40	30	CL
3	34- 63	35	50	15	SiCL
4	63-100	35	50	15	SiCL

Note: * Wind blown deposit and salt crust were excluded.

Profile No.29

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0- 4	36	7.4	131.6	2.3	1,980	651	845	295	1,491	2.0	63	4.0
2	4-21	84	7.9	47.0	2.3	675	263	275	155	509	0.6	35	5.0
3	21-34	82	7.9	56.6	2.2	780	349	480	240	410	1.0	22	0.4
4	34-72	75	7.7	53.7	1.8	831	238	154	306	610	0.9	40	0.5

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 4	35	10	55	SiL
2	4-21	50	25	25	C
3	21-34	70	5	25	C
4	34-72	55	25	20	C

Profile No.43

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^-	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0-15*	65	7.2	54.6	1.3	792	298	193	397	500	1	29	0.8
2	15-50	75	7.6	27.8	2.6	378	177	98	169	290	0.6	25	1.8
3	50-75	80	7.6	19.2	2.1	210	158	82	117	170	0.5	17	3.8

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0-15*	55	10	35	C
2	15-50	75	20	5	C
3	50-75	80	15	5	C

Note: * Wind blown deposit and salt crust were excluded.

5. Port Said Series - Ps 2 Type

Profile No.2

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^-	Anions Cl^-	Anions SO_4^-	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	2-16*	71	7.6	37.5	3.1	490	257	174	65	510	0.9	47	0.7
2	16-46	75	7.6	135.9	3.5	2,332	396	390	330	2,011	1.2	106	0.5
3	46-80	70	7.4	80.8	2.6	1,300	318	212	207	1,200	1.5	83	0.4

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	2-16*	73	18	9	C
2	16-46	64	27	9	C
3	46-80	70	22	8	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.11

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Cl^-	SO_4^{--}	Cations Ca^{++}	Mg^{++}	Na^+	K^+	SAR	$CaCO_3$ (%)
1	2-10*	61	7.7	85.5	3.3	1,492	211	242	182	1,280	1.7	88	0.6
2	10-24	73	8.0	60.8	2.4	1,029	190	87	173	959	1.5	84	2.7
3	24-50	65	8.0	26.8	2.2	410	114	65	110	350	0.9	37	3.5
4	50-95	75	8.1	27.0	4.0	441	91	92	73	370	0.9	41	0.9

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	2-10*	44	15	41	C
2	10-24	60	15	25	C
3	24-50	57	25	18	C
4	50-95	84	6	10	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.12

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO --	Cl-	SO --	Cations Ca++	Mg++	Na+	K+	SAR	CaCO (%)
1	10- 25*	60	7.9	85.5	3.4	1,281	425	254	353	1,100	1.5	63	0.5
2	25- 45	67	7.8	95.0	3.8	1,517	380	376	373	1,150	1.8	59	0.3
3	45- 60	59	7.7	121.6	3.4	1,950	469	398	322	1,700	1.9	90	0.2
4	60-100	60	7.7	76.0	3.2	1,110	414	254	256	1,015	1.9	64	0.6

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	10- 25*	25	67	8	SiL
2	25- 45	41	21	38	C
3	45- 60	42.0	33.6	24.4	C
4	60-100	44.3	29.6	26.1	C

Note: * Wind blown deposit and salt crust were excluded.

6. Port Said Series - Ps 3 Type

Profile No.13

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	4- 20*	61	7.7	57	2.8	929	156	134	92	860	2.2	81	1.6
2	20- 40	61	7.7	99.8	3.2	1,517	478	109	97	1,790	2.0	176	2.5
3	40- 60	67	7.6	93.0	2.3	1,456	404	272	228	1,360	1.9	86	1.6
4	60-100	58	7.8	93.0	3.3	1,699	162	221	286	1,355	1.9	85	1.0

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	4- 20*	65	18	17	C
2	20- 40	73	15	12	C
3	40- 60	84	16	10	C
4	60-100	83	6	11	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.19

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Cl^-	SO_4^{--}	Cations Ca^{++}	Mg^{++}	Na^+	K^+	SAR	$CaCO_3$ (%)
1	2-18*	40	7.3	110.4	2.2	1,600	606	232	776	1,198	2.1	53	0.5
2	18-35	57	7.7	90.1	3.2	1,360	447	272	216	1,320	1.7	85	0.9
3	35-67	75	7.8	64.4	2.2	960	325	170	118	998	1.2	83	1.6
4	67-85	74	7.9	55.2	2.0	880	221	112	178	812	1.2	67	2.5

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	2-18*	38	50	12	SiCL
2	18-35	26	60	14	SiL
3	35-67	56	32	12	C
4	67-85	59	31	10	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.25

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Cl-	SO_4^{--}	Cations Ca^{++}	Mg^{++}	Na^{+}	K^{+}	SAR	$CaCO_3$ (%)
1	0.5- 4*	60	7.3	141.9	2.2	2,330	508	159	399	2,280	2.1	77	1.3
2	4- 13	50	7.4	23.5	1.5	380	87	117	138	214	0.4	19	1.6
3	13- 30	55	8.0	41.4	2.0	537	289	153	282	392	0.7	27	1.0
4	30- 55	78	8.0	12.8	3.3	125	36	17	51	96	0.4	17	1.7
5	55-100	86	7.9	29.1	3.5	420	158	64	122	395	0.5	41	1.6

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0.5- 4*	56	26	18	C
2	4- 13	40	38	22	C
3	13- 30	48	39	13	C
4	30- 55	41	45	14	SiC
5	55-100	73	15	12	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.26

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	1-14*	56	7.2	75.2	2.4	1,070	432	191	627	685	1.1	34	0.5
2	14-38	54	7.7	50.7	1.7	780	230	138	373	500	0.9	31	0.5
3	38-60	65	7.4	42.3	3.2	620	223	159	196	490	1.0	37	0.8
4	60-85	67	7.7	51.7	1.9	735	295	227	424	380	1.0	21	0.7

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	1-14*	24	60	16	SiL
2	14-38	30	58	12	SiCL
3	38-60	55	30	15	C
4	60-85	55	30	15	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.32

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0- 20*	64	7.2	69	1.8	962	417	216	704	460	1.2	22	0.5
2	20- 50	70	7.5	34.5	2.0	420	269	105	260	325	0.7	24	1.0
3	50- 68	75	7.9	27.6	2.6	419	128	95	109	345	0.6	34	1.9
4	68-100	77	8.1	20.7	1.8	343	68	74	39	300	0.4	40	0.5

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 20*	55	20	25	C
2	20- 50	75	20	5	C
3	50- 68	85	10	5	C
4	68-100	75	20	5	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.33

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0- 10*	78	7.2	59.1	2.2	811	368	116	564	500	0.8	27	-
2	10- 23	86	7.5	36.4	1.5	472	255	106	312	310	0.6	21	0.2
3	23- 70	84	7.8	22.7	1.8	315	136	98	155	200	0.4	18	1.8
4	70-120	85	7.7	52.7	1.1	790	262	125	415	512	1.1	31	2.5

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 10*	65	20	15	C
2	10- 23	75	10	15	C
3	23- 70	75	20	5	C
4	70-120	85	10	5	C

Note: * Wind blown deposit and salt crust were excluded.

7. Port Said Series - Ps 4 Type

Profile No.8

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3--	Cl-	SO_4--	Cations Ca++	Mg++	Na+	K+	SAR	$CaCO_3$ (%)
1	2.5-15*	62	8.0	74.4	2.0	1,121	365	120	452	915	1.2	54	0.3
2	15-38	60	8.0	36.3	1.5	500	224	94	181	450	0.7	38	0.5
3	38-55	55	8.0	45.7	1.3	640	278	84	174	660	0.8	58	0.5
4	55-80	50	8.0	55.8	1.9	980	134	174	336	605	0.8	38	1.1

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	2.5-15*	39	53	8	SiCL
2	15-38	31	58	11	SiCL
3	38-55	16	74	10	SiL
4	55-80	7	72	21	SiL

Note: * Wind blown deposit and salt crust were excluded.

Profile No.15

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0- 10*	33	7.1	144	1.5	2,361	411	307	563	1,902	2.0	91	0.3
2	10- 37	83	7.2	93	1.8	1,300	560	231	409	1,220	1.9	68	0.6
3	37- 60	62	7.3	79.1	1.8	1,121	449	231	339	1,000	1.0	59	0.5
4	60- 85	68	7.6	74.4	1.8	1,266	214	120	239	1,122	0.9	84	0.8
5	85-110	74	7.5	83.7	2.2	1,260	414	176	274	1,225	1.0	82	1.4

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 10*	14	71	15	SiL
2	10- 37	57	25	18	C
3	37- 60	70	18	12	C
4	60- 85	77	6	17	C
5	85-110	84	6	10	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.16

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3--	Cl-	SO_4--	Cations Ca++	Mg++	Na+	K+	SAR	$CaCO_3$ (%)
1	0- 6*	55	7.3	128	1.8	2,470	690	563	797	1,800	2.2	108	0.4
2	6-25	35	7.4	111.6	2.4	2,055	456	514	572	1,425	2.0	56	0.6
3	25-40	49	7.6	69.6	2.2	1,170	229	109	391	900	0.9	57	0.5
4	40-55	41	7.6	69.7	1.9	1,015	371	120	339	928	0.9	61	2.0

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0- 6*	48	30	22	C
2	6-25	20	52	28	SiL
3	25-40	14	62	24	SiL
4	40-55	12	62	26	SiL

Note: * Wind blown deposit and salt crust were excluded.

8. Port Said Series - Ps 5 Type

Profile No.1

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	1- 4*	67	7.2	144.4	3.3	1,964	814	403	761	1,774	2.4	74	0.3
2	4-25	68	7.4	85.5	2.4	1,274	429	185	438	1,080	1.7	61	0.2
3	25-65	62	7.6	66.5	2.2	1,078	215	196	74	1,025	1.1	88	0.9
4	65-110	61	8.1	62.8	2.9	990	263	142	306	825	1.0	55	0.4

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture
1	1- 4*	60	33	7	C
2	4-25	59	28	13	C
3	25-65	52	38	10	C
4	65-110	52	18	8	SiC

Note: * Wind blown deposit and salt crust were excluded.

Profile No.3

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	1- 5*	73	7.3	78.9	2.6	1,160	403	251	394	920	1.4	51	0.8
2	5-18	77	7.8	55.1	3.0	833	269	218	406	480	1.0	27	0.5
3	18-80	69	7.5	76.0	3.1	1,225	392	296	323	1,000	1.1	57	1.2

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture
1	1- 5*	59	34	7	C
2	5-18	76	22	2	C
3	18-80	69	23	8	C

Note: * Wind blown deposit and salt crust were excluded.

9. Manzala Series - Ma 1 Type

Profile No.6

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	1- 18*	56	7.4	55.1	2.2	880	229	142	288	680	0.6	46	0.5
2	18- 43	56	7.2	150	1.8	2,518	459	318	500	2,160	1.2	107	0.4
3	43- 70	46	7.4	124.8	1.5	1,940	555	558	662	1,275	2.1	52	0.5
4	70-100	48	7.4	120.5	1.6	2,191	223	627	632	1,155	2.2	46	0.5

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	1- 18*	51	41	8	SiC
2	18- 43	43	48	9	SiC
3	43- 70	27	62	11	SiL
4	70-100	15	73	12	SiL

Note: * Wind blown deposit and salt crust were excluded.

Profile No.17

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3--	Cl-	SO_4--	Cations Ca++	Mg++	Na+	K+	SAR	$CaCO_3$ (%)
1	2- 7*	43	7.1	98.5	2.4	1,413	567	368	632	980	1.5	44	0.1
2	7- 19	28	7.2	140.7	2.8	1,920	894	480	834	1,500	2.5	59	0.6
3	19- 47	67	7.4	51.6	2.6	686	347	135	450	450	0.9	26	0.1
4	47- 80	59	7.6	46.9	1.9	637	299	153	274	510	0.8	35	0.6
5	80-120	65	7.8	44.6	1.7	588	304	152	261	480	0.8	33	0.6

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	2- 7*	18	48	34	L
2	7- 19	48	40	12	SiC
3	19- 47	12	70	18	SiL
4	47- 80	10	66	24	SiL
5	80-120	18	72	10	SiL

Note: * Wind blown deposit and salt crust were excluded.

Profile No.20

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3--	Cl-	SO_4--	Cations Ca++	Mg++	Na+	K+	SAR	$CaCO_3$ (%)
1	1- 7*	51	7.2	56.4	1.5	920	209	270	270	590	1.0	36	0.9
2	7-17	51	7.2	70.5	2.0	1,176	232	233	371	805	1.2	46	1.3
3	17-40	46	7.4	38.2	1.3	470	292	106	306	350	0.7	24	2.0
4	40-60	50	7.8	25.7	1.3	321	192	95	128	290	0.5	28	1.3
5	60-85	48	7.7	22.6	2.2	290	163	85	120	250	0.4	25	1.3

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	1- 7*	41	41	18	SiC
2	7-17	34	52	14	SiCL
3	17-40	30	56	14	SiCL
4	40-60	30	52	18	SiCL
5	60-85	30	58	12	SiCL

Note: * Wind blown deposit and salt crust were excluded.

10. Manzala Series - Ma 2 Type

Profile No.4

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhoc/cm at 25°C	me/ℓ Anions HCO_3--	Cl-	SO_4--	Cations Ca++	Mg++	Na+	K+	SAR	$CaCO_3$ (%)
1	2- 6*	80	7.4	22.2	3.0	245	194	70.8	85.5	284	0.7	32	1.6
2	6- 27	80	7.7	66.5	1.8	980	349	126	196	1,008	1.0	79	2.2
3	27- 45	83	8.2	40.4	2.2	383	405	154	226	409	0.8	30	1.0
4	45-140	73	8.1	14.4	2.2	155	47	55	29	120	0.3	19	4.0

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	2- 6*	66	30	4	C
2	6- 27	51	41	8	SiC
3	27- 45	61	27	12	C
4	45-140	63	27	10	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.21

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cation Ca^{++}	Cation Mg^{++}	Cation Na^+	Cation K^+	SAR	$CaCO_3$ (%)
1	1- 7*	42	7.7	150.4	2.2	2,410	599	583	626	1,800	2.4	73	0.9
2	7- 37	30	8.2	103.4	2.2	1,520	546	318	664	1,084	2.0	49	0.2
3	37- 55	30	8.0	61.1	1.6	960	259	313	477	430	1.2	22	0.4
4	55-100	29	8.1	89.3	1.5	1,215	568	307	716	760	1.7	34	0.3
5	100-120	25	8.2	79.9	2.0	1,120	475	212	439	945	1.2	52	0.5

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	1- 7*	41	34	25	C
2	7- 37	52	36	12	C
3	37- 55	51	33	16	C
4	55-100	14	16	60	SL
5	100-120	10	33	57	SL

Note: * Wind blown deposit and salt crust were excluded.

Profile No.23

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^-	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	4-13*	64	7.5	145.7	2.2	2,350	562	414	1,145	1,353	2.0	49	1.6
2	13-30	64	7.5	84.6	1.7	931	758	386	573	730	1.5	33	1.3
3	30-46	68	7.7	74.3	1.1	1,020	465	230	330	925	1.3	55	1.3
4	46-62	70	7.8	61.1	1.5	784	435	270	320	630	1.2	37	2.5
5	62-90	70	8.0	45.0	1.5	730	169	106	144	650	1.1	58	1.2

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	4-13*	54	28	18	C
2	13-30	58	26	16	C
3	30-46	59	25	16	C
4	46-62	60	24	16	C
5	62-90	58	26	16	C

Note: * Wind blown deposit and salt crust were excluded.

Profile No.24

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	0-10*	64	7.3	103	1.7	1,575	485	402	458	1,200	2.0	58	0.4
2	10-16	64	7.5	75.2	1.8	1,211	288	285	275	940	1.1	56	0.5
3	16-35	41	7.5	32.9	1.3	343	311	106	173	375	0.5	32	0.2
4	35-60	61	7.5	22.5	2.2	280	168	95	115	240	0.4	23	0.5
5	60-90	61	7.5	42.3	1.5	637	207	127	152	566	0.6	48	1.0

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	0-10*	59	23	18	C
2	10-16	58	24	18	C
3	16-35	42	42	16	SiC
4	35-60	50	26	14	C
5	60-90	50	22	18	C

Note: * Wind blown deposit and salt crust were excluded.

11. Manzala Series - Ma 3 Type

Profile No.10

Chemical Analysis

Sample No.	Depth (cm)	SP	pH in soil paste	EC mmhos/cm at 25°C	me/ℓ Anions HCO_3^{--}	Anions Cl^-	Anions SO_4^{--}	Cations Ca^{++}	Cations Mg^{++}	Cations Na^+	Cations K^+	SAR	$CaCO_3$ (%)
1	8-16*	54	7.4	20.2	2.1	301	101	140	254	210	0.3	21	1.4
2	16-27	66	7.7	19.0	3.1	250	109	119	53	190	0.3	21	1.3
3	27-55	68	8.2	116.3	3.3	2,000	377	205	313	1,860	2.1	116	2.5
4	55-85	53	8.2	46.5	2.6	684	246	164	148	620	0.9	50	1.6

Mechanical Analysis

Sample No.	Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture (%)
1	8-16*	9	79	2	SiL
2	16-27	31	64	5	SiCL
3	27-55	35	62	3	SiCL
4	55-85	27	68	5	SiL

Note: * Wind blown deposit and salt crust were excluded.

C-3 Mechanical and Chemical Analysis Data of Soil Samples Taken in the High Dam Soil Survey (1963)

1. Mechanical Analysis

Mapping Unit	Sample Number	Depth cms	Mechanical analysis (micron) (%) < 2	2-20	20-50	50-100	100-200	> 200	TNV as % $CaCO_3$	TSS %	Texture	Remarks
Ms 2/3	742	0 - 30	49.9	39.5	7.1	3.4	3.4	3.4	4.4	7.3	SiC	Ms 3 in the present
		30 - 60	59.7	32.1	6.4	1.6	1.6	1.6	2.0	5.4	C	Survey
Ms_3	786	100 -120	37.2	20.0	12.8	3.8	12.9	3.5	1.0	4.7	CL	Near the Area
Ps1	769	10 - 20	55.9	17.0	15.7	2.7	0.7	1.1	0.8	6.55	C	Ps1
Ps3(1)	746	0 - 40	18.9	41.0	21.3	6.5	12.1	12.1	1.0	8.45	SiL	Ps1
		90 -120	52.9	29.7	13.5	1.7	0.3	0.1	0.7	11.61	C	
Ma1	745	10 - 30	79.0	17.8	1.0	11	2.1	2.1	0.0	10.22	C	Ms3
Ma2(1)	757	160 -180	19.2	49.8	24.4	6.5	6.5		0.2	3.51	SiL	Near the Area

2. Chemical Analysis

Mapping Unit	Sample No.	Depth (cm)	SP (%)	pH	EC mmhos	SAR	Remarks
Ms 2/3	740	50- 80	64	8.0	79.4	67	Ms 1
Ms 2/3	741	0- 40	91	7.5	63.8	54	Ms 3
		80-100	61	7.5	88.5	68	
Ms 2/3	742	0- 30	91	7.6	66.4	54	Ms 3
		30- 60	83	7.4	66.4	57	
		100-120	100	7.4	83.6	74	
Ms 2/3	743	0- 30	85	7.5	83.6	65	Ms 1
		30- 60	99	7.4	86.0	76	
		100-120	108	7.4	93.4	84	

Sample No.	Anions in me/liter				Cations in me/liter				
	HCO_3	Cl	SO_4	Total	Ca	Mg	Na	K	Total
740	4	980	100	1,084	63	235	820	15	1,133
741	1.5	800	65	867	117	133	600	7	857
	2	1,070	138	1,210	79	269	900	8	1,255
742	2.5	750	125	878	81	209	650	9	949
	2.5	790	120	913	76	184	650	7	917
	2	1,030	1,425	1,175	63	232	900	7	1,202
743	2	990	128	1,220	81	259	850	10	1,200
	1.5	960	75	1,037	79	171	850	10	1,110
	2	1,070	83	1,155	60	169	900	10	1,140

Mapping Unit	Sample No.	Depth (cm)	SP (%)	pH	EC mmhos	SAR	Remarks
Ps 1	748	100-120	93	7.3	47.4	57	Ps 2
ps 1	749	0- 40	70	6.9	142.1	90	Ps 2
		50- 70	75	7.1	151.6	111	
		80-100	80	7.3	106.6	82	
Ps 1	769	10- 20	79	7.4	116	69	Ps 1
Ps 2	768	10- 30	64	7.1	95.3	47	Ps 1
		40- 60	65	7.2	131.6	57	
		70- 90	69	7.0	68	41	
		140-160	74	7.2	61.3	43	
		180-200	85	7.1	49.9	32	

Sample No.	Anions in me/liter				Cations in me/liter				
	HCO_3	Cl	SO_4	Total	Ca	Mg	Na	K	Total
748	2.5	530	35	568	47	63	425	5	540
749	3	2,290	140	2,434	189	571	1,750	15	2,525
	3	2,500	195	2,698	173	482	2,000	22	2,677
	3	1,510	65	1,578	105	290	1,150	11	1,556
769	1.5	1,566	50	1,618	185	325	1,100	6	1,616
768	2.5	2,360	105	2,468	528	730	1,175	12.5	2,444
	1.5	2,115	5	2,122	389	562	1,250	15	2,215
	2	1,605	45	1,652	310	548	850	9	1,716
	2	1,025	52	1,079	192	273	650	7	1,122
	2.5	465	60	528	74	132	325	4.5	534

Mapping Unit	Sample No.	Depth (cm)	SP (%)	pH	EC mmhos	SAR	Remarks
Ps 3	739	5- 20	65	6.7	154	84	Ma 1
		40- 60	65	7.1	129	69	
		70- 90	73	7.1	116.5	69	
Ps 3 (1)	746	0- 40	106	7	142.2	78	Ps 1
		90-120	71	7.2	139	84	
Ps 3 (1)	747	0- 20	67	7.5	76.9	67	Ps 2
		40- 60	82	8.2	127.9	85	
		80-100	62	6.6	108.9	76	
Ps 3	751	10- 40	75	6.9	141.5	36	Ps 3
Ps 3	752	80-100	50	6.9	161.6	72	Ps 3
Ps 3	753	10- 40	40	7.7	15.7	28	Ms 3
Ps 3	754	0- 10	95	7.6	66	44	Ms 3
		50- 60	83	7.4	51.9	36	
		90-110	68	7.5	56.5	38	

Sample No.	Anions in me/liter				Cations in me/liter				
	HCO_3	Cl	SO_4	Total	Ca	Mg	Na	K	Total
739	1	2,540	25	2,566	289	536	1,712	20	2,557
	2.5	1,790	70	1,863	236	414	1,250	6	1,906
	2	1,670	18	1,690	200	360	1,150	5	1,715
746	1.5	2,370	193	2,564	260	610	1,625	12.5	2,508
	1.5	2,079	60	2,141	201	479	1,550	15	2,245
747	2	930	95	1,027	92	193	800	9	1,094
	3	1,740	180	1,923	126	344	1,300	12	1,782
	3	1,570	135	1,708	136	359	1,200	12	1,707
751	2.5	2,240	20	2,263	593	747	937	10	2,287
752	1	2,800	20	2,821	499	611	1,688	10	2,808
753	1	115	34	150	18	20	120	2	160
754	3.5	800	50	854	136	123	500	4	793
	3	600	30	633	95	126	378	3	602
	2.5	680	45	728	110	140	425	5	680

Mapping Unit	Sample No.	Depth (cm)	SP (%)	pH	EC mmhos	SAR	Remarks
Ma 1	744	70- 90	65	8.2	101.0	71	Ms 3
		100-120	55	8.0	122.6	80	
Ma 1	745	10- 30	56	7	122.9	54	Ms 3
		40- 60	80	7.4	99	78	
		80-100	68	7.4	113.1	58	
		100-120	63	7.3	93.4	72	
Ma 1 (1)	760	5- 20	72	7.3	93.4	69	Ps 1
		30- 50	68	7.4	113.0	60	
		90-110	76	7.3	93.4	51	

Sample No.	Anions in me/liter				Cations in me/liter				
	HCO_3	Cl	SO_4	Total	Ca	Mg	Na	K	Total
744	3.5	1,360	115	1,479	79	334	1,025	17	1,455
	1.5	1,650	53	1,705	84	411	1,250	16	1,761
745	1.0	2,360	63	2,424	263	824	1,250	22.5	2,360
	1.5	1,150	175	1,327	158	127	925	22	1,232
	1	1,570	93	1,664	221	562	800	11	1,594
	2.5	1,320	18	1,340	84	306	1,000	9	1,399
760	1.5	1,200	120	1,322	87	307	970	8	1,372
	1.5	1,510	70	1,582	202	461	1,100	10	1,773
	1.5	1,350	53	1,404	186	386	870	6	1,448

Mapping Unit	Sample No.	Depth (cm)	SP (%)	pH	EC mmhos	SAR	Remarks
Mal (1)	761	30- 50	59	7.2	179.7	127	Ps1
		70- 90	64	7.2	169.8	128	
Mal (1)	763	20- 40	60	7.3	140.7	76	Ps3
		70- 90	66	7.1	113.5	63	
		170-190	90	7.3	65.8	54	
Mal (1)	764	0- 30	45	6.5	204.3	164	Ps5
		40- 60	62	7.2	154.3	90	
Mal (1)	765	0- 10	59	7.4	62.5	23	Ps5 (Ma2)
		40- 60	69	7.7	33.6	27	
		100-120	84	7.4	27.7	28	
Mal (1)	766	10- 30	60	7.3	125.0	34	Ma2
		50- 70	69	7.8	62.5	39	
Mal (1)	767	20- 40	70	7.1	63.5	26	Ma1
		130-150	73	7.1	77.0	30	

Sample No.	Anions in me/liter				Cations in me/liter				
	HCO_3	Cl	SO_4	Total	Ca	Mg	Na	K	Total
761	3	3,060	10	3,073	210	515	2,425	17.5	3,168
	3	2,920	30	2,953	179	471	2,300	15	2,965
763	1.5	2,620	80	2,702	383	532	1,625	12.5	2,552
	2.5	1,615	69	1,686	126	405	1,020	6	1,555
	2	1,110	15	1,127	226	209	800	4	1,239
764	1.5	5,385	438	5,824	630	715	4,250	15	5,610
	2.5	2,330	28	2,360	305	456	1,750	10	2,520
765	3.5	750	40	794	289	124	325	3.5	742
	3	340	5	348	63	75	225	2.7	366
	3.5	270	28	301	42	63	205	2.2	312
766	2.5	1,830	240	2,073	504	606	800	7	1,917
	4	750	38	792	142	138	460	6.5	747
767	3	1,065	43	1,111	357	373	500	6	1,236
	1	1,510	23	1,534	509	448	650	4	1,611

Mapping Unit	Sample No.	Depth (cm)	SP (%)	pH	EC mmhos	SAR	Remarks
Ma2 (1)	750	20- 40	62	6.4	127.9	70	Ma2
		100-120	75	6.1	80.5	60	
Ma2 (1)	755	5- 20	59	7.1	142.1	141	Near the Area (Ma2)
		160-180	58	7.1	109.0	105	
Ma2 (1)	756	10- 30	126	7.6	52.1	52	Near the Area (Ma2)
		50- 70	168	7.5	47.4	44	
		90-110	150	7.6	47.4	44	
Ma2 (1)	757	0- 10	68	7.6	37.9	29	Near the Area (Ma2)
		30- 50	68	7.5	53.3	34	
		70- 80	70	7.4	48	43	
		160-180	60	7.2	62.5	47	

Sample No.	Anions in me/liter				Cations in me/liter				
	HCO_3	Cl	SO_4	Total	Ca	Mg	Na	K	Total
750	3.5	2,010	95	2,109	173	602	1,375	7	2,157
	3	1,030	115	1,148	110	290	850	4	1,254
755	1.5	2,530	50	2,582	210	300	2,250	5	2,765
	1.5	1,530	45	1,577	126	204	1,350	5	1,685
756	2	615	128	745	92	111	520	3	726
	1.5	400	135	537	63	84	375	2	529
	3	475	925	571	71	84	385	2	542
757	1.5	350	55	407	100	65	263	1.2	429
	1.5	650	15	667	127	113	375	3	618
	1	570	25	596	89	106	425	2.5	622
	1.5	760	23	784	131	139	550	6	826

Mapping Unit	Sample No.	Depth (cm)	SP (%)	pH	EC mmhos	SAR	Remarks
Ma2 (1)	758	0- 10	36	5.9	204.7	88	Ma2
		70- 90	78	7.5	26.2	35	
		120-140	68	7.4	27.5	33	
Ma2 (1)	759	10- 30	73	7.3	149.8	49	Ma2
		40- 60	55	7.2	124.8	44	
		120-140	60	6.8	114.8	34	
		140-160	69	6.9	92.4	31	
		160-180	94	7.1	77.4	40	
Ma3 (1)	762	80-100	75	7.8	20.7	33	Ps5
		190-210	95	8.1	12.3	31	

Sample No.	Anions in me/liter				Cations in me/liter				
	HCO_3	Cl	SO_4	Total	Ca	Mg	Na	K	Total
758	3	5,490	5	5,498	1,433	1,317	3,250	10	6,010
	2.5	290	8	300	53	32	225	1.2	311
	3	290	5	298	53	42	225	1.2	321
759	3	2,860	10	2,873	667	918	1,375	7.5	2,968
	3	1,990	10	2,003	454	589	1,000	5	2,048
	3.5	1,700	25	1,729	420	553	750	6	1,729
	3.5	1,280	5	1,289	312	431	600	6	1,349
	3.5	920	13	936	213	237	600	4	1,054
762	3	180	30	213	26	27	170	1.4	224
	3.5	100	3	106	11	11	102	1.4	125

Note: These soil samples were not taken from all over the present Project Area but from the sites near the border lines.

APPENDIX C - 4.

Additional Analyses of Soil and Water Samples Taken in the Project Area.

(C-4-1) Other Chemical Analysis Data of Soils

(C-4-2) Groundwater Analysis

(C 4-3) and EC of Various Water Samples Taken in the Project Area

(C-4-4) EC and Salt Content of Some Soil Extracts

(C-4-5) Changes of and EC by Successive Extraction of Some Soils with Water

(C-4-6) Estimates of Amount of Soluble Salts Contained in Some Profile Soils

(C-4-1) Chemical Analysis Data of Soils

1. Ms 1 Type

Prof. No.	Depth cm	pH 1/	CEC 2/	Gypsum Content %	Soluble nitrogen ppm	Soluble phosphorus ppm
34	0- 15	8.7	19.5	0.42	33.8	4.5
	15- 36	8.0	21.5	4.7	41.2	5.5
	36- 80	8.1	-	10.8	-	-
2. Ms 2 Type						
31	0- 5	7.8	-	8.7	-	-
	5- 15	8.1	28.5	6.8	77.9	7.5
	15- 35	8.2	42.0	1.4	27.9	6.0
	35- 50	8.2	-	7.1	-	-
36	0- 12	7.6	19.0	4.1	52.9	7.5
	12- 40	8.0	-	1.2	-	-
	40- 57	8.3	-	-	-	-
	57- 90	8.3	-	-	-	-
37	0- 10	7.8	18.5	1.4	70.6	7.5
	10- 19	8.2	19.5	0.72	64.7	7.0
3. Ms 3 Type						
28	0- 8	7.8	-	2.8	-	-
	8- 17	7.9	26.5	2.8	42.7	6.5
	17- 37	8.2	-	0.71	-	-
	37- 78	8.3	-		-	-
30	8- 25	8.5	31.0	0.72	44.1	6.0
	25- 40	8.2	42.0	-	35.3	4.5
	40- 55	8.2	40.0	0.49	30.9	4.5
	55- 80	7.6	-	0.86	-	-

Note: 1/ Soil-water 1:2.5
2/ me per 100g soil

3. Ms 3 Type (Continued)

Prof. No.	Depth cm	pH 1/	CEC 2/	Gypsum content %	Soluble nitrogen ppm	Soluble phosphorus ppm
35	0- 10	7.3	38.5	-	57.4	5.5
	10- 45	8.1	-	8.1	-	-
	60- 80	8.0	-	2.1	-	-
	85-100	8.7	-	0.18	-	-
42	1- 18	8.0	18.5	-	44.1	4.5
	18- 44	8.5	-	1.5	-	-
	44- 78	8.4	-	0.83	-	-
	78-110	8.6	-	18.6	-	-
4. Ps-1 Type						
5	1- 8	7.4	17.0	10.0	52.9	2.5
	8- 42	7.6	-	10.4	-	-
	42- 65	7.8	-	4.2	-	-
	65-100	8.0	-	1.9	-	-
14	4- 15	8.4	24.0	4.5	36.8	3.5
	15- 28	8.2	20.5	3.6	16.2	2.5
	28- 63	8.4	21.5	1.2	23.5	2.5
	63- 85	8.2	-	0.47	-	-
18	0- 9	8.2	32.5	1.9	20.6	3.0
	9- 20	7.7	-	2.2	-	-
	20- 45	8.4	-	1.8	-	-
	45- 80	8.4	-	0.70	-	-
	80-110	7.8	-	1.5	-	-
22	0.5- 11	8.0	-	12.4	-	-
	11- 35	8.2	35.5	0.40	52.9	7.5
	35- 60	8.3	-	0.76	-	-
	60- 90	8.1	-	-	-	-

Note: 1/ Soil-water 1:2.5
2/ me per 100g soil

4. Ps 1 Type (Continued)

Prof. No.	Depth cm	pH 1/	CEC 2/	Gypsum content %	Soluble nitrogen ppm	Soluble phosphorus ppm
27	2- 15	7.8	-	-	-	-
	15- 34	7.8	30.5	-	61.8	4.0
	34- 63	8.0	-	13.8	-	-
	63-100	8.1	-	2.7	-	-
29	0- 4	8.3	-	7.0	-	-
	4- 21	8.2	34.5	-	48.5	8.0
	21- 34	8.3	-	1.3	-	-
	34- 72	8.3	-	-	-	-
43	0.3- 15	7.8	11.5	-	77.9	2.0
	15- 50	8.0	20.5	-	52.9	2.5
	50- 75	7.9	24.0	0.91	58.8	4.0
5. Ps 2 Type						
2	2- 16	8.1	-	4.3	-	-
	16- 46	7.7	18.5	5.5	29.4	4.0
	46- 80	7.8	-	8.6	-	-
11	2- 10	8.1	16.0	6.8	30.9	3.0
	10- 24	8.5	-	1.7	-	-
	24- 50	8.5	-	1.7	-	-
	50- 95	8.6	-	1.1	-	-
12	0- 25	8.3	6.5	12.4	10.3	3.5
	25- 45	8.1	18.0	2.0	25.0	4.0
	45- 60	8.0	-	0.72	-	-
	60-100	8.1	-	0.28	-	-

Note: 1/ Soil-water 1:2.5
2/ me per 100g soil

6. Ps 3 Type

Prof. No.	Depth cm	pH 1/	CEC 2/	Gypsum content %	Soluble nitrogen ppm	Soluble phosphorus ppm
13	4- 20	8.0	20.0	6.8	26.5	2.0
	20- 40	8.0	-	6.3	-	-
	40- 60	8.2	-	1.1	-	-
	60- 85	7.9	-	0.33	-	-
19	2- 18	-	28.5	10.8	64.7	4.5
	18- 35	-	-	6.8	-	-
	35- 67	-	-	2.4	-	-
	67- 85	-	-	0.82	-	-
25	0- 4	7.4	11.0	17.3	62.2	4.5
	4- 13	8.1	19.5	6.3	70.0	3.5
	13- 30	8.5	27.0	0.03	26.5	4.0
	30- 55	8.3	-	1.4	-	-
	75-100	7.4	-	0.19	-	-
26	1- 14	7.7	29.0	-	41.2	4.0
	14- 38	7.8	-	8.6	-	-
	38- 60	7.9	-	2.4	-	-
	60- 85	8.1	-	-	-	-
32	0- 20	7.8	34.0	-	91.2	11.0
	20- 50	8.0	-	13.7	-	-
	50- 68	8.2	-	4.9	-	-
	68-100	8.4	-	5.7	-	-
33	0- 10	7.7	-	2.3	-	-
	10- 23	8.0	27.5	0.84	48.5	5.5
	23- 70	8.2	-	9.7	-	-
	70-100	8.1	-	12.0	-	-

Note: 1/ Soil-water 1:2.5
2/ me per 100g soil

7. Ps 4 Type

Prof. No.	Depth cm	pH 1/	CEC 2/	Gypsum content %	Soluble nitrogen ppm	Soluble phosphorus ppm
8	2.5- 15	7.4	17.5	1.3	32.4	3.0
	15- 38	8.3	15.0	2.3	19.1	7.0
	38- 55	8.7	-	0.36	-	-
	55- 85	8.4	-	-	-	-
15	0- 10	7.9	-	9.1	-	-
	10- 37	8.1	21.5	9.4	77.9	3.0
	37- 60	8.3	-	14.6	-	-
	60- 85	8.3	-	4.5	-	-
	85-110	8.4	-	2.5	-	-
16	0- 6	7.9	-	2.2	-	-
	6- 25	8.2	17.5	15.4	47.1	4.0
	25- 40	8.4	-	12.3	-	-
	40- 55	8.4	-	1.2	-	-
8. Ps 5 Type						
1	1- 4	7.5	-	9.6	-	-
	4- 25	7.8	16.5	5.5	22.1	4.5
	25- 65	7.8	16.0	10.7	32.4	7.5
	65-110	8.3	-	6.9	-	-
3	1- 5	7.8	-	9.7	-	-
	5- 18	7.8	-	3.6	-	-
	18- 50	8.0	23.0	2.1	28.0	2.5
9. Ma 1 Type						
6	1- 18	7.7	13.0	15.7	63.2	3.0
	18- 43	8.2	-	13.0	-	-
	43- 70	7.7	-	7.7	-	-
	70-100	7.4	-	6.3	-	-

Note: 1/ Soil-water 1:2.5

2/ me per 100g soil

9. Ma 1 Type (Continued)

Prof. No.	Depth cm	pH 1/	CEC 2/	Gypsum content %	Soluble nitrogen ppm	Soluble phosphorus ppm
17	2- 7	7.5	-	7.1	-	-
	7- 19	7.9	14.5	6.2	52.9	7.0
	19- 47	8.7	28.5	1.9	29.4	4.0
	47- 80	8.4	-	1.0	-	-
	80-120	8.3	-	0.70	-	-
20	1- 7	8.0	-	9.4	-	-
	7- 17	8.2	32.5	5.1	77.9	4.5
	17- 40	8.2	-	2.4	-	-
	40- 60	8.4	-	2.0	-	-
	60- 85	8.3	-	0.79	-	-
10. Ma 2 Type						
4	2- 6	8.4	-	2.5	-	-
	6- 27	7.9	19.0	4.8	38.2	4.5
	27- 45	8.4	-	1.8	-	-
	45-140	8.5	-	0.58	-	-
21	1- 7	7.7	21.5	8.1	60.3	2.5
	7- 37	8.1	23.5	3.1	38.2	7.5
	37- 55	8.0	24.0	3.7	97.0	4.5
	55-100	8.1	-	0.27	-	-
	100-120	8.2	-	-	-	-
23	4- 13	8.0	22.0	4.7	79.4	7.5
	13- 30	8.3	23.5	-	48.5	11.0
	30- 46	8.3	-	-	-	-
	46- 62	7.9	-	-	-	-
	62-100	8.3	-	-	-	-

Note: 1/ Soil-water 1:2.5
2/ me per 100g soil

10. Na 2 Type (Continued)

Prof. No.	Depth cm	pH 1/	CEC 2/	Gypsum content %	Soluble nitrogen ppm	Soluble phosphorus ppm
24	0- 10	7.9	-	3.1	-	-
	10- 16	8.1	-	2.2	-	-
	16- 35	8.0	9.5	0.52	26.5	5.0
	35- 60	7.9	-	1.1	-	-
	60- 85	7.6	-	0.36	-	-
11. Na 3 Type						
10	8- 16	7.6	19.0	7.2	38.2	4.5
	16- 27	8.6	21.5	1.3	17.7	7.5
	27- 55	8.7	22.0	0.46	14.7	4.0
	55- 80	8.1	-	-	-	-

Note: 1/ Soil-water 1:2.5
2/ me per 100g soil

(C-4-2) Groundwater Analysis (1) Spot Analysis - 1

Soil Type	Pit No.	Sample No.	Depth of Groundwater	pH	EC Measurement			Salt of Water
					Dilution x	EC mmho/cm, 25°C	Salt** ppm	ppm (NaCl, %)
Ms 1	34	G 18	36	7.20	10	8.83	5,651	56,510 (4.90)
Ms 2	31	G 15	55*	7.08	50	3.75	2,400	120,000 (9.85)
Ms 2	47	G 22	58	6.70	40	8.60	5,500	200,000 (18.80)
Average			57	6.89				170,000 (14.33)
Ms 3	28	G 12	78	6.95	50	4.44	2,840	142,000 (11.90)
Ms 3	30	G 14	60*	7.15	50	1.67	1,070	53,500 (4.20)
Ms 3	42	G 20	78	7.30	10	3.38	2,160	21,600 (1.80)
Average			72	7.13				72,367 (5.97)
Ps 1	5	G 2	83*	6.68	50	5.10	3,260	163,000 (13.75)
Ps 1	14	G 4	95	7.10	50	2.96	1,890	94,500 (7.80)
Ps 1	18	G 6	85	6.80	50	4.96	3,170	158,500 (13.35)
Ps 1	22	G 9	82	6.70	50	2.98	1,910	95,500 (7.90)
Ps 1	27	G 11	85*	6.90	25	3.58	2,290	57,250 (4.80)
Ps 1	29	G 13	85*	7.00	50	4.26	2,730	136,500 (11.35)
Average			86	6.86				117,542 (9.83)

Remarks: Analysed soonafter sampling at San El Nagar.
* Gush water above the groundwater level was mixed.
** ECx 640 ppm(5)

Groundwater Analysis (1) Spot Analysis - 2

Soil Type	Pit No.	Sample No.	Depth of Groundwater	pH	EC Measurement			Salt of Water
					Dilution x	EC mmho/cm, 25°C	Salt** ppm	ppm (NaCl, %)
Ps 2	2	G 1	85	6.90	50	8.37	5,360	268,000 (23.50)
Ps 2	11	G 3	80	7.25	50	4.55	2,910	145,500 (12.25)
Average			83	7.08				206,750 (17.88)
Ps 3	19	G 7	87	7.20	50	4.37	2,800	140,000 (12.25)
Ps 3	26	G 10	85	6.90	20	4.94	3,160	63,200 (5.24)
Ps 3	32	G 16	82	7.45	50	1.58	1,010	50,500 (4.00)
Ps 3	33	G 17	85	6.70	25	4.22	2,700	67,500 (5.70)
Ps 3	39	G 19	86	7.05	20	7.20	4,610	92,200 (7.84)
Average			85	7.06				82,680 (7.01)
Ps 4	16	G 5	90	7.00	50	5.96	3,810	190,500 (16.15)
Ps 5	46	G 21	90	7.20	10	8.70	5,570	55,700 (4.85)
Ma 1	20	G 8	100*	6.50	50	5.64	3,610	180,500 (15.50)
All Average			78	6.99				125,839 (10.71)

Remarks: Analysed soonafter sampling at San El Hagar.
* Gush water above the groundwater level was mixed.
** ECx 640 ppm (S)

Groundwater Analysis (2) Laboratory Analysis-1

Soil Type	Sample No.	EC 1/	Anions (me/liter)				Cations (me/liter)				SAR
			HCO_3^-	Cl^-	SO_4^{--}	Total	Ca^{++}	Mg^{++}	Na^+	K^+	
Ms 1	G 18	82.7	5.9	1,270	378	1,654	122	639	892	1.0	46
Ms 2	G 15	103.7	2.2	1,617	449	2,068	143	503	1,420	2.0	79
Ms 2	G 22	160.0	4.4	2,630	556	3,200	153	1,075	1,965	2.5	79
Ms 3	G 12	139.1	4.4	2,290	488	2,782	98	1,004	1,678	2.2	72
Ms 3	G 14	35.7	5.3	441	268	714	119	192	402	0.8	32
Ms 3	G 20	32.0	5.2	343	292	640	131	98	410	0.7	38
Ps 1	G 2	137.0	3.3	2,101	636	2,739	403	824	1,510	1.5	61
Ps 1	G 4	74.3	4.0	1,012	467	1,493	272	320	900	1.0	52
Ps 1	G 6	126.0	4.8	2,154	365	2,524	287	361	1,894	1.7	104
Ps 1	G 9	103.5	3.9	1,797	270	2,701	240	539	1,290	1.5	65
Ps 1	G 11	73.3	3.7	1,029	433	1,466	165	335	965	1.3	61
Ps 1	G 13	137.2	5.5	1,960	778	2,744	176	658	1,908	2.4	93

Note: 1/ mmhos/cm at 25°C

Groundwater Analysis (2) Laboratory Analysis-2

Soil Type	Sample No.	EC 1/	Anions (me/liter)				Cations (me/liter)				SAR
			HCO_3^-	Cl^-	SO_4^{--}	Total	Ca^{++}	Mg^{++}	Na^+	K^+	
Ps 2	G 1	165.0	4.4	2,675	625	3,304	349	1,003	1,950	2.0	75
Ps 2	G 3	57.0	4.4	980	198	1,182	87	294	800	1.0	58
Ps 3	G 7	57.0	4.6	970	169	1,144	87	296	760	1,0	55
Ps 3	G 10	92.1	3.1	1,372	467	1,842	186	542	1,112	1.5	58
Ps 3	G 16	55.5	6.2	836	268	1,110	99	235	775	1.2	60
Ps 3	G 17	134.4	4.4	2,103	581	2,688	219	822	1,645	2.2	72
Ps 3	G 19	95.9	4.2	1,470	444	1,918	164	450	1,300	1.5	74
Ps 4	G 5	134.0	4.4	2,000	659	2,663	283	528	1,850	1.5	92
Ps 5	G 21	75.2	3.3	1,225	276	1,504	122	400	980	1.5	61
Ma 1	G 8	190.0	2.1	2,863	939	3,804	566	785	2,450	2.5	94

Note: 1/ mmhos/cm at 25°C

(C-4-3) pH and EC of Various Water Samples Taken in the Project Area

Sample No.	Date of sampling	Location of sampling	pH	ECw 3/	Salt Concentration 1/ ppm
1. Canal Water					
C 1	8/30	Canal 67	8.05	5.06	3,238
C 2-1	8/30	Gandal El Sufle	8.10	1.60	1,024
C 2-2	9/17	Do, near D1	7.80	1.60	1,024
C 3	9/11	Daffan	8.05	2.18	1,395
C 4	9/22	Sami	8.15	0.71	454
C 5	9/22	Canal 5,000 (Taimor)	8.14	6.51	4,166
2. Drain Water					
D 1	8/28	Bahr El Bagar	7.60	2.13	1,364
D 2-1	10/ 1	Ramses (Hagar)	7.80	2.34	1,498
D 2-2	10/ 4	Do, near Dibgu	7.90	3.32	2,125
D 3-1	8/31	Bahr El Saft (Hagar)	7.65	2.09	1,338
D 3-2	9/17	Do, San El Hagar	7.85	1.93	1,235
D 3-3	9/ 9	Do, San Baharia	7.78	3.72	2,381
D 4	9/18	Hadus	7.80	2.12	1,357
3. Blind Canal Water					
B 1	9/ 2	Hossein No.6	8.20	44.4 2/	28,416
B 2-1	9/22	Taimor, Pit No.48	8.25	13.4 2/	8,576
B 2-2	9/22	Do, Pit No.50	7.30	10.2	6,528
4. Water of Fish Pond and Salt Lake					
L 1	10/ 7	Pond near Ramses	8.05	6.13	3,923
L 2	10/ 9	Pond near Dibgu	7.45	12.3 2/	7,872
L 3	9/21	Lake, Pit No.2	6.62	420.0 2/	268,800
L 4	9/ 4	Lake, Pit No.23	7.55	553.0 2/	353,920

Note: Samples were analysed on the same day as they were taken.

1/ ECw x 640(5)

2/ Determined on diluted samples

3/ mmhos/cm at 25°C

(C-4-4) EC and Salt Content of Some Soil Extracts

Soil Type	Sample No.	Depth cm	pH of soil 1:5	Dilution of extract d	EC of diluted extract (EC_sd) mmhos/cm, 25°C	Salt content % 1/
Ms 2	31-1	0- 5	7.22	20	2.60	16.6
	2	5- 15	7.52	8	2.60	6.7
	3	15- 35	7.70	8	1.84	4.7
	4	35- 50	7.70	6	2.10	3.9
Ms 3	35-1	0- 10	8.20	8	1.93	4.8
	2	10- 45	8.20	8	1.15	2.9
	3	45- 60	8.35	6	1.55	3.0
	4	60-100	8.22	6	1.30	2.5
Ps 1	22-1	0.5- 11	7.30	20	2.58	16.5
Ps 1	29-1	0- 4	8.20	20	2.23	14.3
	2	4- 21	7.92	20	1.18	7.8
	3	21- 34	7.90	20	0.86	5.5
	4	34- 72	7.95	10	1.59	5.1
Ps 1	43-1	0.3- 15	7.60	10	3.60	11.5
	2	15- 50	7.80	8	2.68	6.9
	3	50- 75	7.80	8	2.15	5.5
Ps 2	45-1	1- 8	7.60	20	3.72	23.8
	2	8- 17	6.85	10	6.13	19.6
	3	17- 68	7.80	10	5.62	18.0
	4	68- 80	7.80	10	4.84	15.5

Note: pH was determined of 1:5 soil-water suspension of the samples on the same day as they were taken from the field. The supernatant (extract) was diluted suitably with distilled water and used for EC determination at the measurable mmho range.

1/ $EC_sd \times 0.064 \times 5d$ (5)

Soil Type	Sample No.	Depth cm	pH of soil 1:5	Dilution of extract d	EC of diluted extract (EC_5d) mmhos/cm, 25°C	Salt content % 1/
Ps 5	1-1	1- 4	7.15	40	4.48	57.3
Ps 5	48-1	0.2- 6	7.06	20	4.55	29.1
	2	6- 23	7.40	10	2.75	8.8
	3	23- 60	7.55	8	4.45	11.4
	4	60- 90	7.38	8	5.80	14.8
Ps 5	49-1	1- 5	7.45	20	3.95	25.3
	2	5- 12	7.40	10	7.51	24.0
	3	12- 22	7.90	4	5.05	6.5
	4	22- 60	7.95	4	4.50	5.8
	5	60-100	7.95	2	5.58	3.6
Ma 1	40-1	4- 17	7.52	6	5.54	10.6
	2	17- 44	7.70	4	3.23	4.1
	3	44- 76	7.70	4	4.37	5.6
	4	76-100	7.80	4	3.77	4.8
Ma 1	44-1	2- 12	7.07	20	5.67	36.3
	2	12- 40	7.55	10	4.10	13.1
	3	40- 65	7.60	8	5.91	15.1
	4	65-100	7.55	8	5.40	13.8
Ma 2	21-1	1- 7	7.35	40	3.10	39.7

Note: pH was determined of 1:5 soil-water suspension of the samples on the same day as they were taken from the field. The supernatant (extract) was diluted suitably with distilled water and used for EC determination at the measurable mmhos range.

1/ $EC_5d \times 0.064 \times 5d$

(C-4-5) Changes of pH and EC by Successive Extraction of Some Soils with Water

1. Soil samples used

Soil sample number	11-0	29-1	40-1	40-2	40-3	40-4	45-1
Soil Type	Ps 2	Ps 1	Ma 1	"	"	"	Ps 2
Elevation of Pit site (m)	0.7	0.8	1.3	"	"	"	0.6
Depth of groundwater (cm)	80	85	110	"	"	"	88
Layer number	0	1	2	3	4	5	1
Depth of Layer (cm)	0-1	0-4	4-17	17-44	44-76	76-100	1-8
Layer feature	Wind-blown sand with gypsum flakes	Dry-salt-crust	Under puffy Salt Layer, gypsum flakes	Moist, Soft, gypsum flakes	Slightly Wet, Soft	Moist, hard, Strongly structured	Under Salt-crust, moist, gypsum flakes
Soil color	10YR 4/4	2.5Y 5/2	10YR 3/3	10YR 3/3	10YR 3/3	10YR 4/3	10YR 4/2
Texture	SiL	C	SiCL	SiCL	SiCL	C	C
pH (1:5)	7.70	8.20	7.52	7.70	7.70	7.80	7.60

Note: The extraction was repeated by the following procedure using 20g of air-dry soil after saturating with distilled water: The suspension made with 5 volumes of water is determined of pH after 1 hour and stood for 1 to 2 days, then the supernatant is decanted as much as possible. The decantate is adjusted to 100 ml with water and determined of EC after diluting it to measurable range.

2. pH of 1:5 soil-water suspension

Extraction No.	11-0	29-1	40-1	40-2	40-3	40-4	45-1
1	7.70	8.85	7.65	7.90	8.08	8.12	7.85
2	8.25	9.50	7.92	8.22	8.42	8.62	8.20
3	8.28	9.65	8.20	8.45	8.93	9.15^{++}	8.40
4	8.60	9.70	8.35	8.50	9.42^{+}	9.55^{+++}	8.50
5	8.65	9.70	8.17	8.35	9.20^{++}	9.43^{+++}	8.43
6	8.70	9.75	8.30	8.40	9.52^{+++}	9.65^{+++}	8.54
7	8.70	9.85	8.32	8.50	9.66^{+++}	9.70^{+++}	8.70
8	8.80	9.85^{+}	-	-	-	-	-
9	8.90	9.88^{++}	-	-	-	-	-
10	8.93	9.90^{+++}	-	-	-	-	-
11	8.95	9.94^{++++}	-	-	-	-	-

3. EC5 of extract (micromho/cm at 25°C)

1	19,400	29,000	23,000	14,000	20,500	12,300	57,000
2	7,000	16,500	6,450	3,800	4,000	2,350	12,800
3	3,670	4,390	2,000	1,470	1,130	750	4,530
4	1,870	1,620	1,750	1,400	490^{+}	390^{++}	2,950
5	1,080	760	1,080	950	260^{+++}	235^{+++}	1,750
6	1,110	720	910	840	183^{+++}	213^{+++}	1,710
7	940	500	840	870	185^{+++}	162^{+++}	1,520
8	923	384^{+}	-	-	-	-	-
9	912	214^{++}	-	-	-	-	-
10	867	120^{+++}	-	-	-	-	-
11	822	80^{+++}	-	-	-	-	-

Note: The extraction was repeated by the following procedure using 20g of air-dry soil after saturating with distilled water: The suspension made with 5 volumes of water is determined of pH after 1 hour and stood for 1 to 2 days, then the supernatant is decanted as much as possible. The decantate is adjusted to 100 ml with water and determined of EC after diluting it to measurable range.

+ - +++ show grades of clay dispersion, slight to strong.

4. Salt concentration of extract (EC_5 x 0.64) (ppm)

Extraction No.	11-0	29-1	40-1	40-2	40-3	40-4	45-1
1	12,416	18,560	14,720	8,960	13,120	7,872	36,480
2	4,480	10,560	4,128	2,432	2,560	1,504	8,192
3	2,349	2,810	1,280	941	723	480	2,899
4	1,197	1,037	1,120	896	314	250	1,888
5	691	486	691	608	166	150	1,120
6	710	461	582	538	117	136	1,094
7	602	320	538	557	118	104	973
8	591	240	-	-	-	-	-
9	584	137	-	-	-	-	-
10	555	77	-	-	-	-	-
11	526	51	-	-	-	-	-

5. Amount of Salts removed by extraction (g/100g soil)

1	6.21	9.28	7.36	4.48	6.56	3.94	18.24
2	2.24	5.28	2.06	1.22	1.28	0.75	4.10
3	1.17	1.41	0.64	0.47	0.36	0.24	1.45
4	0.60	0.52	0.56	0.45	0.16	0.13	0.94
5	0.35	0.24	0.35	0.30	0.08	0.08	0.56
6	0.36	0.23	0.29	0.27	0.06	0.07	0.55
7	0.30	0.16	0.27	0.28	0.06	0.05	0.49
8	0.30	0.12	-	-	-	-	-
9	0.29	0.07	-	-	-	-	-
10	0.28	0.04	-	-	-	-	-
11	0.26	0.03	-	-	-	-	-
Total	12.36	17.38	11.53	7.47	8.56	5.26	26.33

Note: The extraction was repeated by the following procedure using 20g of air-dry soil after saturating with distilled water: The suspension made with 5 volumes of water is determined of pH after 1 hour and stood for 1 tO 2 days, then the supernatant is decanted as much as possible. The decantate is adjusted to 100 ml with water and determined of EC after diluting it to measurable range.

(C-4-6) Estimates of Amount of Soluble Salts Contained in Some Profile Soils

Profile No.	Sample No.	Thick-ness (cm)	Salt Content (%)	Salt, ton per (ha)	Salt, ton per (fed.)
	1	5	16.6	83.0	34.9
Ms 2	2	10	6.7	67.0	28.1
|	3	20	4.7	94.0	39.5
31	4	65	3.9	253.5	106.5
	Total	100	-	497.5	209.0
	1	10	4.8	48.0	20.2
Ms 3	2	35	2.9	101.5	42.6
|	3	15	3.0	45.0	18.9
35	4	40	2.5	100.0	42.0
	Total	100	-	294.5	123.7
	1	4	14.3	57.2	24.0
Ps 1	2	17	7.8	132.6	55.7
|	3	13	5.5	71.5	30.0
29	4	66	5.1	336.6	141.4
	Total	100	-	597.9	251.1

Profile No.	Sample No.	Thick ness (cm)	Salt Content (%)	Salt, ton per (ha)	Salt, ton per (fed.)
	0	0.3	80.0	24.0	10.1
Ps 1	1	14.7	11.5	169.1	71.0
|	2	35	6.9	241.5	101.4
43	3	50	5.5	275.0	115.5
	Total	100	-	709.6	298.0
	0	1	80.0	80.0	33.6
Ps 2	1	7	23.8	166.6	70.0
|	2	9	19.6	176.4	74.1
45	3	51	18.0	910.0	385.6
	4	32	15.5	496.0	208.3
	Total	100	-	1,837.0	771.6
	0	0.2	80.0	16.0	6.7
Ps 5	1	5.8	29.1	168.8	70.9
|	2	17	8.8	149.6	62.8
48	3	37	11.4	421.8	177.2
	4	40	14.8	592.0	248.6
	Total	100	-	1,348.2	566.2

(C-4-6, continued)

Profile No.	Sample No.	Thick-ness (cm)	Salt Content (%)	Salt, ton per (ha)	(fed.)
	1	4	25.3	101.2	42.5
Ps 5	2	7	24.0	168.0	70.5
|	3	10	6.5	65.0	27.3
49	4	38	5.8	220.4	92.6
	5	41	3.6	147.6	62.0
	Total	100	-	702.2	294.9
	0	4	50.0	200.0	84.0
Ma 1	1	13	10.6	137.8	57.9
|	2	27	4.1	110.7	46.5
40	3	32	5.6	179.2	75.2
	4	24	4.8	115.2	48.4
	Total	100	-	742.9	312.0
	1	10	36.3	363.0	152.4
Ma 1	2	28	13.1	366.8	154.1
|	3	25	15.1	377.5	158.6
44	4	37	13.8	510.6	214.4
	Total	100	-	1,617.9	679.5

Remarks: Amount of salts in each of the samples are calculated using the figures in (C-4-4) and following equations:

Tons/ha: Thickness (cm) x Salt content(%)

Tons/fed.:Ibid x 0.42

where some assumptions are,

a) taking apparent density as 1.0, weight of 1 cm-thick soil is 1 ton/ha,

b) non-sampled salty crusts is estimated to have 50 to 80% of salts depending on the feature observed and is added to calculation,

c) salt content of the last deepest sample is used to cover the remaining part down to the depth of 100 cm.

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