THE ARAB REPUBLIC OF EGYPT

GENERAL AUTHORITY FOR REHABILITATION
PROJECT AND AGRICULTURAL DEVELOPMENT

MINISTRY OF DEVELOPMENT, STATE
FOR HOUSING, AND LAND RECLAMATION

FINAL REPORT
ON
FEASIBILITY STUDY
FOR
THE SOUTH HUSSINIA VALLEY AGRICULTURAL DEVELOPMENT PROJECT PHASE II

(MAIN REPORT)

MAY 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Arab Republic of Egypt, the Japanese Government decided to conduct a feasibility study on the South Hussinia Valley Agricultural Development Project Phase II and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Egypt a survey team headed by Mr. Shoji Yamada from October 1983 to December 1983.

The team exchanged views with the officials concerned of the Government of Egypt and conducted a field survey. After the team return to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Arab Republic of Egypt for their close cooperation extended to the team.

May 1984

Keisuke Arita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Keisuke Arita
President
Japan International Cooperation Agency

Dear Sir,

We are extremely glad to submit herewith the final report on the Feasibility Study for the South Hussinia Valley Agriculture Development Project phase II in the Arab Republic of Egypt.

As for the Project Study the field surveys had been carried out for about two month from October in 1983, and during stay in the Project site, the survey team had frequently held many discussion meetings with the Egyptian authorities concerned in connection with the project planning and report has been compiled in Japan with the results of said procedures.

The objectives of the study are to make a comprehensive development plan through the Phase II works involving land reclamation, animal husbandry, cash crop production, farm products processing and rural development and the results of the Feasibility study Phase I carried out in 1980 are the base for the Phase II study.

We are convinced that the successful agricultural development in the area, when realized according to the direction indicated in this report, would greatly contribute to the socio-economic development of the country in future.

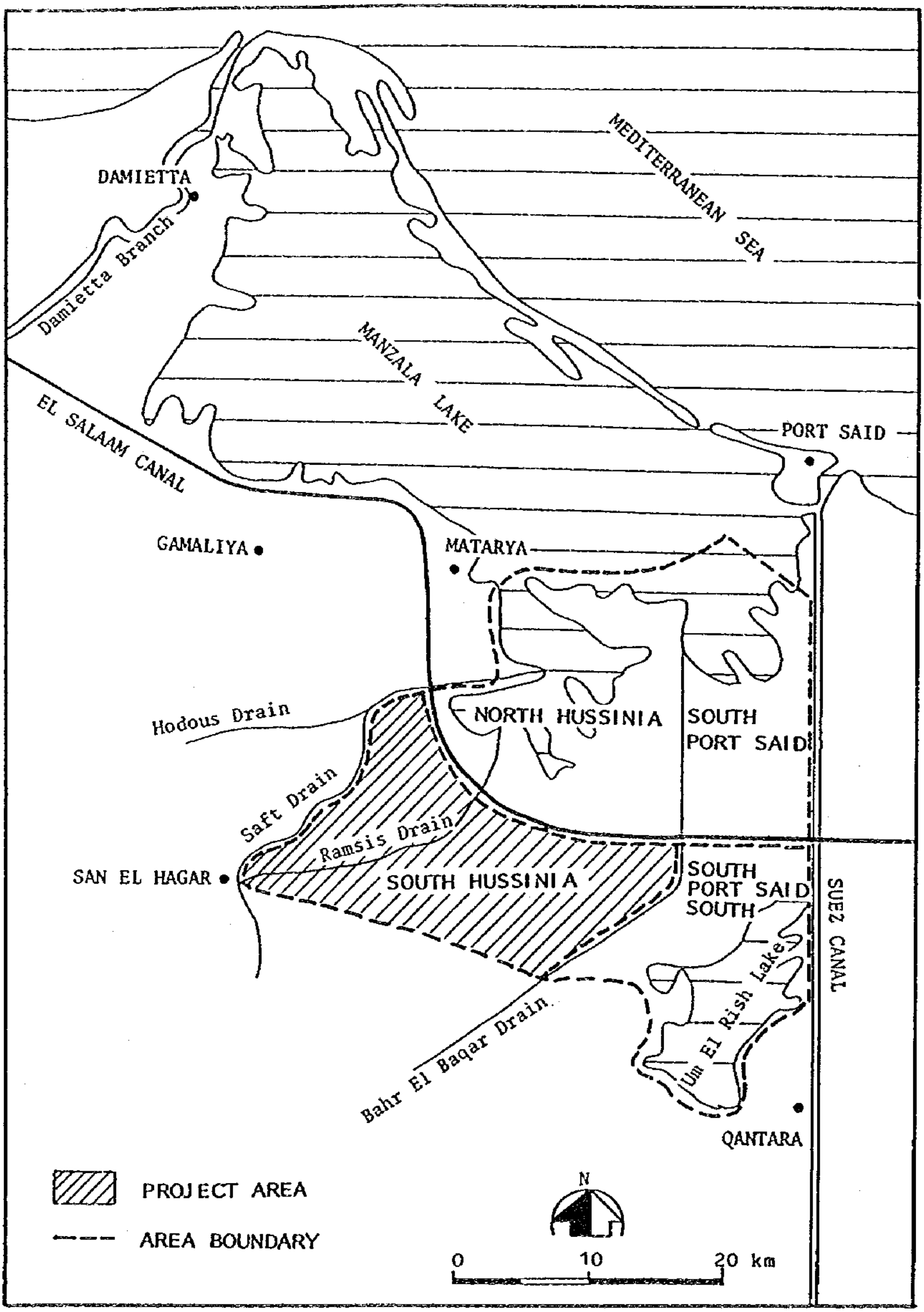
We wish to extend our deep gratitude to the Ministry of Land Reclamation, Ministry of Irrigation and Ministry of Agriculture of the Governments of Egypt, and the Ministry of Foreign Affairs, the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan, and the Japan International Cooperation Agency (JICA), especially for the Japanese Embassy in Cairo, Cairo Office of JICA, and the advisory group which are given useful advices to the survey team from time to time so as to smoothen the study.

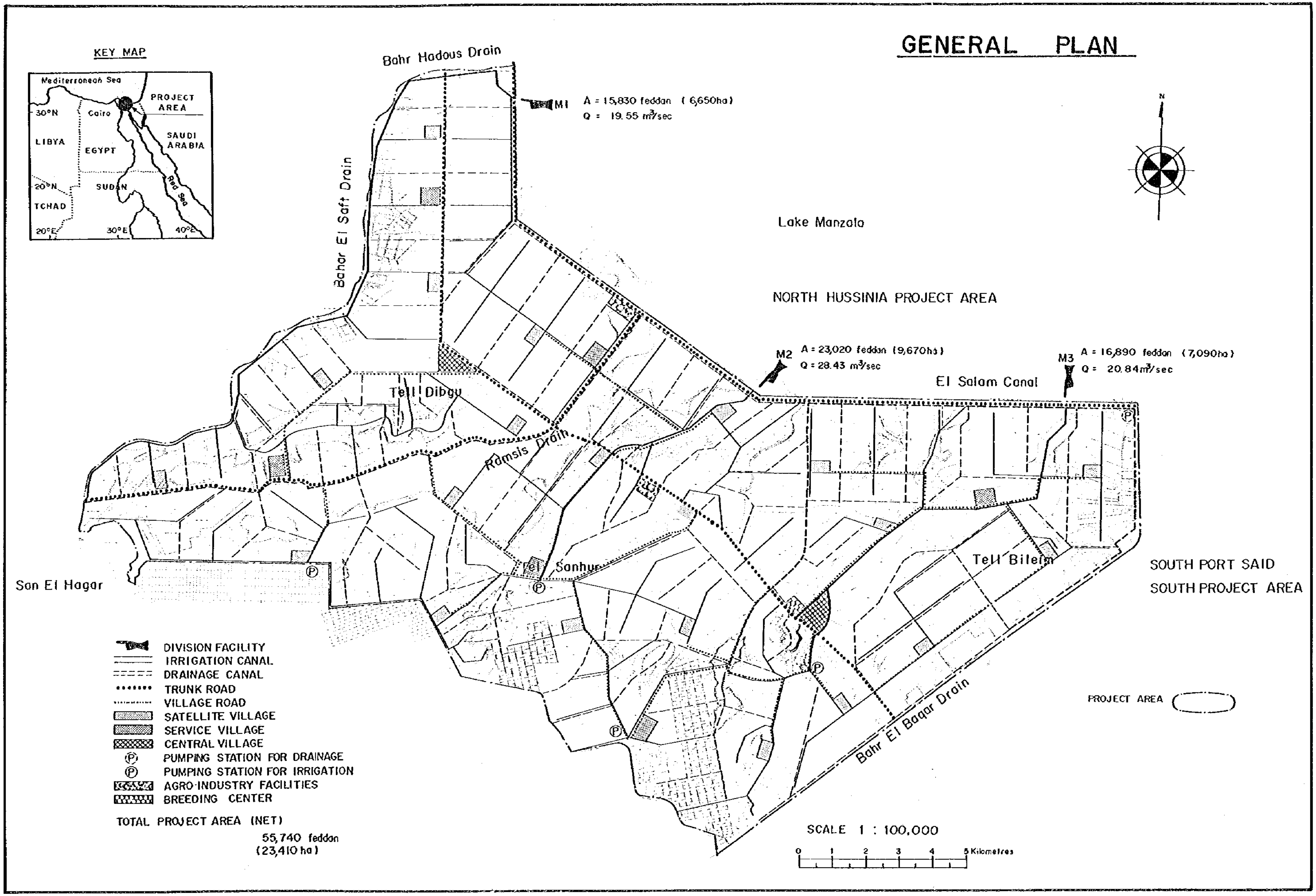
Sincerely yours,

May, 1984

Shoji Yamada
Leader of the Feasibility Study
Team for the South Hussinia Valley
Agriculture Development Project
Phase II

THE SOUTH HUSSINIA VALLEY
AGRICULTURAL DEVELOPMENT PROJECT PHASE II
LOCATION MAP




GENERAL PLAN
KEY MAP
Mediterranean Sea
PROJECT AREA
30°N
Cairo
LIBYA
EGYPT
SAUDI ARABIA
SUDAN
Red Sea
20°N
TCHAD
20°E
30°E
40°E
Bahr Hadous Drain
M1
A = 15,830 feddan (6,650ha)
Q = 19.55 m³/sec
Bahar El Saft Drain
Lake Manzala
NORTH HUSSINIA PROJECT AREA
M2
A = 23,020 feddan (9,670ha)
Q = 28.43 m³/sec
M3
A = 16,890 feddan (7,090ha)
Q = 20.84m³/sec
El Salam Canal
Tell Dibgu
Ramsis Drain
Tel Sanhur
Tell Bileim
San El Hagar
SOUTH PORT SAID
SOUTH PROJECT AREA
Bahr El Baqar Drain
PROJECT AREA
DIVISION FACILITY
IRRIGATION CANAL
DRAINAGE CANAL
TRUNK ROAD
VILLAGE ROAD
SATELLITE VILLAGE
SERVICE VILLAGE
CENTRAL VILLAGE
PUMPING STATION FOR DRAINAGE
PUMPING STATION FOR IRRIGATION
AGRO-INDUSTRY FACILITIES
BREEDING CENTER
TOTAL PROJECT AREA (NET)
55,740 feddan
(23,410 ha)
SCALE 1 : 100,000
0 1 2 3 4 5 Kilometres

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ABBREVIATIONS AND GLOSSARY

Abbreviations and Glossary

ARE	:	Arab Republic of Egypt
MLR	:	Ministry of Land Reclamation
MOI	:	Ministry of Irrigation
MOA	:	Ministry of Agriculture
JICA	:	Japan International Cooperation Agency
FAO	:	Food and Agriculture Organization
GARPAD	:	General Authority for Rehabilitation Project and Agricultural Development
O&M	:	Operation and Maintenance
EIRR	:	Economic Internal Rate of Return
CIF	:	Cost, Insurance, and Freight
FOB	:	Free on Board
LC	:	Local Currency
FC	:	Foreign Currency
LE	:	Egyptian Pound = 1.22 US$ = 288 Japanese Yen
$, US$	:	Dollar, US$ = 0.82 LE

Unit 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

Volume

,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
sec	: second
hr,hrs	: hour or hours
min	: minute
max	: maximum
%	: percent
PPM	: parts per million
No.	: number
HP, PS	: horse power

Conversion Factor

Hectare(ha) = 10,000 sq.m

Feddan = 4,200 sq.m

Cubic Meter(cu.m) = 1,000 liters

1 horserpower(metric) = 75 kg-m per second

= 550 ft-1b per second

1 cu.m per day per feddan = 0.238 mm/day = 2.38 /day/ha

SUMMARY , CONCLUSION AND RECOMMENDATION

Summary, Conclusion and Recommendation

A. Summary

1. Background

In September, 1979, the government of Egypt requested the government of Japan for close cooperation in execution of the South Hussinia Agriculture Development Project.

In reply to this, the government of Japan dispatched a preliminary survey team and a feasibility study team between February and November, 1980, for extending positive cooperation in both technical and financial fields. The final feasibility study report on the Phase I Project was prepared and submitted to the Egyptian government in March, 1981.

Afterwards, the Egyptian authorities concerned requested the Japanese government for cooperation in the development project including cash crops production, animal husbandry, farm products processing and rural community development.

In February, 1983, the Japanese government decided to carry out the Phase II feasibility study of the South Hussinia Valley Agricultural Development Project so as to meet the requirements of the government of Egypt, and dispatched a preliminary survey team in August, 1983 and a feasibility study team from October through December, 1983. The government of Egypt has been executing the five year development plan for the period between 1982/83 and 1986/87 so as to expand its national economy quantitatively and to increase employment opportunities. The new five year plan includes the El Salam Canal Construction Project and the North and the South Hussinia Valley Farm Land Reclamation Projects as links of the whole delta area development plan. Among many development programmes, the

South Hussinia Valley Agriculture Development has been given the highest priority in its implementation.

2. Project Area

The proposed Project Area of 74,700 feddan (about 31,400 ha) extends in the northeastern part of the Delta, about 25 km west of the Suez canal and about 150 km northeast of the Greater Cairo, belonging administratively to Sharkia governorate. The estimated population of 50,000 persons is found in San El Hagar and its neighbouring villages in the Project Area. The Project Area includes about 7,800 feddan of the existing farm land and about 29,000 feddan of submerged land. The Area inclines north to east by gentle slope ranging from 1/5,000 to 1/10,000, and is specified topographically into two, one is flat land represented by submerged land in the north and the other is hillock land with elevation ranging from one to three meter in the south.

The rivers and canals related to the Project Area are the Nile (Damietta branch), El Salam Canal, Bahr Hadous Drainage Canal, Bahr Saft Drainage Canal, and Bahr Baqar Drainage Canal. Bahr Hadous Drainage Canal is one of the major drainage canals in the eastern Delta.

The aforesaid existing farm land in the Area has kept its productivity at the same level as that of the farm land existing in the peripheral areas. Paddy, cotton and maize are the summer crops, while wheat, vegetables and berseem are the winter crops grown in the Area. The water sources for such cultivation depend entirely upon Bahr Saft Drainage Canal, the irrigation water from which is introduced by gravity system to irrigation canals and lifted up to the fields by small-scale lifting facilities; so-called "Sakia" which is operated by draft animals.

At present, the Project Area is poorly drained. The elevation of submerged land of about 29,000 feddan (12,180 ha), occupying about 40 percent of the Area ranges from EL 0.25 m to EL 0.5 m, whereas the water level fluctuates between EL 0.0m and EL 0.5 m. The said submerged land lies quite flat and acreage of submerged areas changes as the water level of the Manzala Lake fluctuates. Completion of the construction works of El Salam Canal, however, will prevent water intrusion from the Manzala Lake.

3. Land Resources

3.1. The Project Area, located at the northeastern edge of the Nile Delta, is composed of gently sloped flat land of river-marine deposits, including swamps and submerged land. This wide flat land of clayey soils extends almost naked with scarce vegetation of drought and salinity-resistant Tamarix because of soil salinity concentration and shortage in water available for crop growing. The salinity-resistant plants of Salicornia and Phragmitis grow in the swamps and submerged land.

3.2. The soils in the Project Area, in general, consist of thick montmorillonite clayey layer and some hardened layers are found deep in parts. Fundamentally, the soils in the Area are composed in a process that the soil salinity has been accumulated on the ground surface or topsoil layer due to capillary phenomenon of shallow saline groundwater under extremely high evapotranspiration. These soils are classified by Standards of Department of Agriculture, U.S.A., into the following three; Typic Salorthids with saline-accumulated Salic layer, Typic Gypsiorthids with gypsic layer containing gypsum, and Typic Torriorthents with specifically unidentical layers. The soils of the swamps and submerged land, always saturated with high saline content water, consists of a clayey layer indicating gleization.

3.3. Approximately two-thirds of the soils of the Project Area is so poor in drainability that the drainage improvement will become vitally important prior to leaching of the soils for successful farm land reclamation. The major factors to limit the soil drainability are the montmorillonite clayey soils, immatured soil texture, shallow groundwater, impervious hardened soil layer found deep, highly exchangeable natrium, etc. According to definition given by Salinity Control Research Institute, U.S.A., the soils of the entire Project Area can be classified as saline soils, about 90 percent of which, both in surface and deep, shows ECe value by more than 18 mS/cm and requires leaching for excessive soluvable salinity contents. Some part of the Project Area, particularly a part of the existing farm land, shows an exchangeable natrium contents by more than 15 percent and is found as natrium-alkarine soils. Soil alkarization will not only adversely affect vegetation but extremely reduce the soil drainability. Highly exchangeable natrium will destroy the soil texture to worsen the soil drainability through dispersion.

3.4. The in-situ permeability tests, soil profile survey, and groundwater table survey have resulted in preparation of soil classification maps of the Area by their reclamation potential, and the reclaimable land of about 68,760 feddan (28,880 ha or about 82%) is found out of the entire land area of 74,700 feddan (31,370 ha).

The unreclaimable land is hollow land and the remaining is found in hillocks. The groundwater table in the Area is observed considerably high and the soils are composed of highly saline clayey layers.

The drainability improvement of the Area requires to fracture the hardened deep layers, to air-dry the surface soils, and to provide pipe drains/open drains properly.

4. The Project

4.1. Purpose of the Project and its Components

The purpose of the Project is to increase the farm land by reclamation of desert land and submerged land, to improve the agricultural productivity by farm mechanization, to create the employment opportunities, to introduce the agro-industry into the rural areas, and to establish the new rural community in the Project Area. The following components are expected for successful implementation of the Project.

a. Agricultural Development Plan

(1) Irrigated agriculture
(2) Animal husbandry
(3) Agro-industry
(4) Agri-supporting services
(5) Farmers' organization

b. Land Reclamation Works

(1) Irrigation/drainage works
(2) On-farm work
(3) Road networks

c. Rural Development Plan

4.2. Proposed Land Use and Cropping Pattern

4.2.1. Proposed land use

The Project covers the total land area of 74,700 feddan (31,370 ha), which includes about 7,800 feddan (3,200 ha) of the existing farm land. A comparative study was made on whether the aforesaid existing farm land is included in the proposed beneficial area or not for formulating a land use plan. The study has concluded that the existing farm land and related farm households should be involved in the proposed Project. This has resulted in total proposed farm land in the Project of 55,740 feddan (23,410 ha), which occupies about 75 percent of the entire Project land area of 74,700 feddan and will be allocated to new settlers. The remaining land will be used for village residence, factories, main canals, secondary canals and terminal facilities, excepting for about 5,330 feddan which will be left intact as uncultivable land.

Proposed Land Use

Item	Present		Proposed	
	Feddan	Hectares	Feddan	Hectares
Farm land	6,000	2,500	55,740	23,400
Submerged land	29,000	12,200	-	-
Cultivable land	39,000	16,500	-	-
Others	400	200	18,960	8,000
Total	74,700	31,400	74,700	31,400

4.2.2. Proposed cropping pattern

Paddy, berseem, sorghum, soybean, beet, cauliflower, onion and cabbage are selected as proposed crops in taking into consideration various requirements of saline-resistance, heavy clayey soils, import substitution, export and economy.

The cropping pattern was prepared in setting the target cropping ratio 200 percent. The soil salinity would be reduced through the following three stages in due consideration of the leaching process. The stage I will cover a period of two to three years after early leaching and the salinity concentration is expected at the level of about 6.0 mS/cm in this stage.

Paddy as summer crop and berseem as winter crop will be grown in the period.

The stage II with three-year rotational cropping will last five years for the land classified by classification 2 and 3, and seven years for the land classified by classification 4. The salinity concentration is expected to be reduced to around 4.0 mS/cm, and paddy, sorghum, and soybean will be grown in summer, while berseem and vegetables (mainly onion, cauliflower and cabbages) will be grown in this stage.

In the stage III the salinity concentration will be decreased to the level of 1.5 mS/cm, and under three-year rotation paddy, soybean, sorghum and vegetables like tomato will be grown as summer crops, while berseem, beet and vegetables like onion, cauliflower, and cabbage as winter crops.

The above proposed cropping pattern was derived from elaborate alternative studies on eight cases in terms of socio-economic analysis.

4.3. Farm Land Reclamation Plan

4.3.1. Soil drainability improvement

In the Project Area, the 1.5 m-deep on-farm open drains will be provided at the interval of 23 m during the land reclamation works, and these open drains are designed to be replaced with pipe drains after leaching is completely over. Without carrying out the soil permeability improvement for the farm land, however, such a drain system might not function so well as expected. Permeability improvement of the soils will be implemented by physical method, biological method and chemical method.

Physical improvement includes deep plowing, crushing hardened deep layers and sandy soil dressing.

Biological improvement will be made by growing deep rooting crops like legumes (alfalfa and Egyptian clover) and dosing a large amount of barnyard manure. Furthermore, shadowing effect of growing crops, vegetation residues and mulching effect by barnyard manure are considered to play an important role in soil improvement.

For chemical improvement, gypsum is dosed for improvement of alkali soils.

The soils in the Project Area can be specified into three by the amount of gypsum required for soil improvement; the first is the soils requiring no dosing of gypsum, the second requiring 2.0 t/feddan and the third requiring 4.0 t/feddan.

4.3.2. Leaching of saline soils

The designed leaching water amount to be required in the Stage I was determined based on three empirical formulas and the data obtained from laboratory leaching tests. In general, the amount of water for appropriate leaching fluctuates by drainability of objective soils and magnitude of salinity concentration; however, for the Project, the amount of 2,350 mm resulting from the V. Kovda's formula has been employed by taking prudent side.

There are two methods for leaching, continuous submergency method and interval submergency method. In many cases, the former is inferior to the latter in leaching efficiency per unit water amount. Under the condition, the interval submergency method has been recommended in this Project. The entire amount of necessary water should not be used by one practice.

About 150 mm shall be used at one practice. The first try shall use 100 mm of water. Except for high temperature and humid summer season, 17 practices should be made in two years. After leaching is practised, paddy and Egyptian clover will be grown. The transitional period from trial cropping pattern to decisive rotational pattern varies from classifications by land development potential.

4.3.3. Soil improvement

Heavy leaching will extremely reduce topsoil fertility due to wash-out of necessary plant nutrients such as nitrogen and phosphorus, together with excessive saline contents harmful to plants. And application of large amount of organic matters will be very effective for improvement of soils interms of physical and chemical features. In an early stage of rotational cropping after land reclamation, chemical fertilizers and a large amount of barnyard manure should be applied in combination for supplementing the nutrients washed away by leaching. Successful soil improvement in the Project Area will require dosage of organic matters of 15 to 20 tons per feddan.

4.3.4. Irrigation

a. On-farm level irrigation water requirements

The crop evapotranspiration was estimated by Blaney-Criddle with data of El Mansula observatory. The estimated value was mutiplied to obtain the following crop-wise average water requirements by crop coefficients which vary with specific features of crops, different time factors for seeding or transplanting.

Crop-wise Average Water Requirements

Crops	ETcrop	Crops	ETcrop
Paddy	842	Sorghum	854
Berseem	464	Onion	439
Soybean	757	Cauliflower	259
Beet	506	Cabbage	197
Tomato	526		

In the Project Area, leaching water supply is indispensable for soil salinity control to ensure successful crop husbandry.

The leaching water requirements were estimated with the following procedures suggested by FAO's Irrigation and Drainage Note No.24, in taking leaching efficiency by 0.5. The estimation resulted to indicate the respective leaching water requirements ranging from 0.1 for soybean to 0.55 for onion. The Project will employ the surface irrigation by basin irrigation method and border strip method. The aforesaid irrigation method has been commonly applied in the fields around the Project Area and allow the high irrigation efficiency and even allocation of water to be secured when adequate land levelling available.

Therefore, the appropriate and effective leaching will be carried out by this method. Under the conditions, the total irrigation efficiency was calculated at 0.64 (On-farm efficiency: 0.75, water conveyance efficiency: 0.85) with rotational irrigation method.

b. Total water requirements

The total water requirements were estimated based on the three-year rotational cropping with 200 percent of cropping ratio to be shown as follows. The annual total requirements will be 7,912 cu.m/feddan for the total Project Area of 74,700 feddan (31,400 ha) and the peak water requirements will take place in July by 39.8 cu.m/feddan, which will be equivalent to 12.7 mm/day for 55,740 feddan of the total farm land of the Area.

Crop-wise Annual Water Requirements

Crops	Acreage (Feddan)	Water Requirements (10^6 cu.m)	Crop	Acreage (Feddan)	Water Requirements (10^6 cu.m)
Summer			Winter		
Paddy	18,580	145.8	Berseem	18,580	94.5
Sorghum	10,580	67.7	Beet	18,580	65.2
Tomato	8,000	33.6	Onion	13,000	74.9
Soybean	18,580	98.5	Cauliflower	2,800	5.8
Sub-total	55,740	345.6	Cabbage	2,780	5.3
			Sub-total	55,740	245.7

Total Water Requirements 591.3 x 10^6 cu.m

Monthly Water Requirements

Month	10^6 cu.m	cu.m/day/fed	Month	10^6 cu.m	cu.m/day/fed
Jan.	45.6	19.7	Jul.	92.2	39.8
Feb.	39.4	18.8	Aug.	78.1	33.7
Mar.	38.6	16.7	Sep.	56.0	25.0
Apr.	15.2	6.8	Oct.	46.4	20.0
May	28.8	12.4	Nov.	37.0	16.5
Jun.	71.8	32.0	Dec.	42.2	18.2

c. El Salam Canal

The Phase I construction works of El Salam Canal which is the water source of the Project are scheduled to be completed in early 1986.

The El Salam Canal, to which the water will be diverted from the Damietta river - a branch of the Nile, will join the drainage canals of Serw and Hadous in its course downward.

Due to such joining with these drainage canals, the water of the El Salam Canal will change its salinity concentration magnitude to a range from 697 ppm to 824 ppm.

d. Water distribution and design discharge

In Egypt, there are many irrigation facilities which have been operated according to the schedule covering the canal discharge and the water distribution period. Ministry of Irrigation has decided that irrigation shall be carried out for four days with four-day intervals during the peak time in summer. This rule will be applied to operation of the irrigation facilities of the Project, and the design discharge for determining the dimensions of the main and lateral canals is computed at 2.94 lit/s/ha (1.23 lit/s/feddan) twice as much as 1.47 lit/s/ha (12.7 mm/day) of the peak requirements.

A typical small irrigation canal branching off from the lateral canal will irrigate a 50-feddan (21 ha) farming block consisting of 10 farm plots and the rotational irrigation will take only one day for irrigating a farming block with eight day interval. In such conditions, the design discharge of the small irrigation canals will be 210 lit/s/21 ha (8 x 1.47 x 0.85 x21), except for conveyance losses in the main and lateral canals.

e. Gravity irrigation and pumping irrigation by farmers

About 64 percent of farm land in the Project Area will be able to be irrigated by gravity system with the designed water level in El Salam Canal. The Project plan was prepared after prudent comparative study for M2 irrigation block covering 23,020 feddan (9,670 ha) which is advantageous in taking gravity irrigation to farm plots with water level hightened in El Salam Canal or in taking Egyptian traditional method of small-size pumping irrigation by farmers. The conditions set for the study were one small pump for 21 ha, 10 years for renewal of main pump while seven years for small-size pump interest rate by 10 percent, and 50 years for analysis.

Comparative Study on Economy

(Unit: 1,000 LE)

Item	Gravity	Pump
Construction Cost		
Canal	7,089	6,026
Main Pumping Station	4,211	2,665
Small Pumping Station	-	8,255
Total	11,300	16,946
Annual Cost		
Repayment Cost	1,140	1,710
Repair Cost	296	550
Equipment Renewal Cost	145	675
Pump Operation cost	36	32
Total	1,617	2,967

In spite of the low cost of canal construction, the pumping irrigation method requires not only a large amount of initial cost, repayment cost and repair cost, but also huge cost for equipment renewal. In this respect, the gravity system is more advantageous in economy.

The Project will provide on-farm facilities as well as construct the main and lateral canal system. Subsequently, there will be no need for farmers to provide their own intake facilities at the main/lateral canals as traditionally practised, even when the gravity system is employed, and this will result in decrease in breakage or destruction of the canal facilities. As a result, the Project will not employ the pumping irrigation method, but the on-farm level gravity irrigation available by construction of the main and lateral canal facilities.

4.3.5. Drainage

The Project Area has an annual rainfall as little as about 50 mm on an average. Therefore, there will be little problem on rain water drainage in the Area, and drainage of the Area aims mainly to carry out subsurface drainage so as to possibly reduce salinity accumulation on the soils. A major supply source of soluble sodium to the soils is both irrigation water and groundwater. Part of irrigation water will be lost through horizontal seepage as well as vertical seepage and surface drainage, and the vertical seepage will cause to raise the groundwater table.

Subsurface drainage can be made by either open drain method or pipe drain method. Merits and demerits of the respective methods can be summarized as follows; the open drains are advantageous in comparatively low initial cost and providing larger drainage capacity, whereas disadvantageous in much loss in land area and high operation and maintenance cost, and the pipe drains are advantageous in no land area loss, no obstacle to farming works and low operation and maintenance cost, whereas disadvantageous in high initial cost, and small drainage capacity.

The drainage plan for the Project was prepared with careful comparative study on open drains and pipe drains for a typical farm land with 2.1 ha (210 m x 100 m) in the Area. The interval between drains is set by 23 m and the groundwater table is lowered below 0.6 m from the ground surface. When employing the open drains, land area loss will be 0.42 ha, resulting in decrease of farming land to 1.68 ha. Other conditions for the study are 20 years for analysis period, interest rate of 10 percent and LE 1,267/ha for target benefit at the full development.

The result of comparison is shown below.

Economic Evaluation of Open Drain and Pipe Drain

(Unit: LE)

Item	Open Drain	Pipe Drain
Initial Cost	3,403	5,864
Annual O/M Cost	270	30
Target Benefit at Full Development	2,129	2,661
Present Value		
- Benefit (B)	9,169	11,460
- Cost (C)	5,046	5,323
B/C Ratio	1.82	2.15

The open drains, although more economical in the initial cost, is inferior to the pipe drains in total economy because the former brings about land area loss that will reduce the farm production. Furthermore, the open drains constructed at 23 m intervals are expected to be obstacles to farming works, although not taken into account in the above evaluation. The pipe drain method will be employed for on-farm drainage in the Project, in due consideration of economy and convenience in farming works. For the successful reclamation of the saline polluted land, however, it is deemed effective to make best use of the open drains with large drainage capacity for heavy leaching in the early stage of land reclamation, though it has disadvantages of obstruction to farm operations and loss of farm land.

Therefore, the open drains shall be provided for effective drainage of leaching water in the early stage of land reclamation, and when the soil salinity concentration is lowered to 4 mS/cm, the open drains shall be replaced with the pipe drains.

4.3.6. Land Consolidation

The shape and size of farm plots are directly affected by factors of working efficiency, operation/maintenance of irrigation and drainage facilities, topography, farm management, etc.

The longer length of run is better for the mechanized works. The larger the ratio of length of run to width may be, the higher the working efficiency may become. In this Project, about 25 percent of the total cropping area will be grown with vegetables, which require much man-power for cultivation; for example, a typical farm household with farm land of five feddan (2.1 ha) will have to spend the working hour in vegetable cropping by about 49 percent of the total working hours. And the length of 100 m is considered to be a limit to the length of run for manual labor.

For drainage, the commanding drainage length of pipe drains is the major factor to limit the length of run. The commanding length will be determined by soil permeability and depth of drainage pipes laying. Experience in the similar natured projects in Egypt tells that the optimum maximum length of run is deemed as long as 100 m. For irrigation, the irrigation efficiency and farm operation shall determine the maximum length of run. To attain the proposed irrigation efficiency, the maximum length shall be around 150 m.

About 80 percent of the entire farm land in the Area will be allocated to the small-size farm households and the farm land allocated to the individual farmers will be divided into three farm plots (0.7 ha), which would be cropped with three-year rotational cropping among upland cropping and paddy cropping according to the proposed plan.

As a result of the study on the aforesaid factors, the length of run of one farm plots (0.7 ha), which would be cropped with three-year rotational cropping among upland cropping and paddy cropping according to the proposed plan.

As a result of the study on the aforesaid factors, the length of run of one farm plot was determined by 100 m in due consideration of efficiency of manual labor in upland farming and pipe drainage efficiency. Such being the case, one typical farm household with five feddan (2.1 ha) will have the farm land in a size of 210 m x 100 m, and one farm plot size will be 100 m x 70 m.

The layout of the farm land in the Area was studied for the following two cases that 100 m long side is set along the lateral canals and 210 m long side is set along the lateral canals. Under the condition that each farm plot would face the farm road or the access to the farm road, and provide the on-farm irrigation ditches and drains or at least irrigation and drainage notches, the comparative study was made. The road canal density, reduction rate and construction cost which were employed in the study are shown follows.

Dimensions for Comparative Study on Land Consolidation

Item	Case I (Proposed Plan)	Case II
1. Shape of Farm Block	1,050 m x 221 m	1,090 m x 435 m
Acreage of Farm Land	50 Feddan (21 ha)	100 Feddan (42 ha)
Number of Owned Blocks	10	20
Number of Plots Construction Cost	30	60
2. Road/Canal Density(m/ha)	250	348
3. Reduction Rate (%)	9.6	11.5
4. Construction Cost (LE/ha)	1,633	2,058

The Case I that 100 m long side of a farm block is set along the lateral canals, is more advantageous than the Case II in effective operation of irrigation and drainage facilities, efficiency in farming works, reduction rate, and construction cost. Therefore, the Project will employ the farm land layout in the Case I.

4.4. Agriculture Development Plan

4.4.1. Land disposal

It is recommendable for the Egyptian Government and or the land reclamation cooperative to implement the works. When the land reclamation cooperative implements the works, the cooperative holds the right for 30 percent of the reclaimed land and the balance will be handed over to the government.

About 20 percent of the government owned land should be offered for tendering. As a result of study the allocation to the new settlers will be made in a manner that five feddan are for small size farm households, 15 feddan for the graduates of agricultural senior high school and 20 feddan for the college graduates, respectively. In general, the allocation ratio of the farm land should be 80 percent for the small-size farm households and 20 percent for the large size farm households. Based on the above ratio, the new settler farmers are expected at 7,836 farmers for five feddan cultivation, and 331 farmers for 20 feddan cultivation, totalling to 8,829 farmers.

4.4.2. Agricultural production

The proposed farm plot has a size of 100 m x 210 m, divided into three pieces with five feddan each. In a direct angle to the 210 m long side, the open drains should be provided at the interval of 23 m for securing successful leaching works. The open drains should be replaced with the pipe drains when the early stage of leaching is successfully over. In this plan, the net farm land acreage will be increased from 44,600 feddan to 55,740 feddan. Agricultural production at the full development stage will be as follows;

Crops	Acreage (feddan)	Yield (ton/feddan)	Production (ton)
Paddy	18,580	3	55,740
Soybean	18,580	1.2	21,630
Sorghum	10,580	18	190,440
Berseem	18,580	25	464,500
Beet	18,580	25	455,210
Tomato	8,000	20	156,800
Onion	13,000	10	127,400
Cauliflower	2,800	5	13,720
Cabbage	2,780	20	54,490

4.4.3. Farming machinery

Introduction of mechanized farming is quite indispensable for successful development of the Project Area. Large-size tractors should be operated for, plowing and soil crushing, when the soils are in dry condition. And medium/small-size tractor should be used for land levelling and puddling, while medium-size combines for harvesting. For upland farming, the medium/small-size tractors should be employed, while power-tillers should be operated for vegetable cropping. Large/medium-size machines shall be owned by agricultural cooperatives, whereas small-size machines by individual farmers.

4.4.4. Farmers' organization

The settler farmers, when settled down in the Area, should organize the agricultural cooperatives, which will work for purchase and sales of input materials, collection and forwarding of farm products, operation and maintenance of large/medium-size farming machinery, and operation and management of workshop of farming machines. Water users' Association should be established under the control of Ministry of Irrigation.

A vegetable growers' association should be established for preparing cropping plans, collection/forwarding plan of products and giving guidance to the members about modern farming techniques.

4.4.5. Animal husbandry

Friesian and Baladi cattle and sheep will be introduced to the Project Area as suitable kinds of animals as a results of comparative study of milk production, milk fat percentage, meat production, delivery interval, economy, etc. A case study was made, including the case with buffalo breeding, assuming insufficient import of Friesian cattle.

Feeding with berseem, sorghum, paddy straw, soybean cake, beet pulp will enable to breed 26,400 head of Baladi, 11,340 head of Friesian and 10,180 head of sheep.

Cattle will be bred by soilage feeding method but not by pasturing method. Type of farm management in the Project Area should be made in a form of "Diverse Farming with animals" but not in a farm of Specialized "Animal Husbandry" as major item.

The products by animal husbandry will be 63,830 tons of milk, 4,130 tons of beef, 53 tons of mutton and 13 tons of wool. About 59,200 tons of the total milk production per annum will be processed. Milk produced in a village will be brought to village milk collection center and transported to a processing plant.

Beef cattle and sheep in the Project Area will be transported to the existing slaughter house in Ismailia.

It is proposed to establish a propagation center providing frozen semen production facilities so as to improve animal fertility.

4.4.6. Agri-supporting services

The powerful agricultural extension services to be rendered by governmental organization are quite essential as a strong agri-supporting organization. The major works expected for successful supporting services are upbringing of leaders of local farmers, strategical intensive guidance of farming techniques by demonstration farm, seeds renewal by seed propagation fields and technical guidance of animal husbandry by extension workers.

In particular, a farmers' training center should be established for successful training of individual farmers.

4.4.7. Processing of farm products

Beet sugar: Beet sugar manufacturing plant to cope with the yearly increasing production from 1989 to 1992 so that the plant can be operated from 1993. The plant will have a daily processing capacity of 6,000 tons on the slicing basis after washing of beet. It is expected to produce beet sugar by about 17 percent of condensed beet liquid through evaporating juice at 90°C. The plant at full operation will be able to produce 67,803 tons of white sugar per annum.

Dairy processing: The plant scale of milk treatment and processing is planned to have a daily treatment capacity of about 162 tons at full operation throughout the year. The capacity will be expanded as the milk production in the Area will be increased. About 59,200 tons of raw milk will be processed to about 23,680 ton of UHT milk, about 440 tons of butter and about 5,920 tons of white cheese.

The processing plant will be constructed for a period from 1988 to 1989 and operation will be started in 1990. It is desirable to provide one processing plant each in North and South Hussinia Project Area, respectively in terms of production control.

Tomato processing: Since tomato cropping in summer will be started in 1997, a tomato paste processing plant should be constructed within a period between 1997 and 2001. And about 141,000 tons of fresh tomato will be processed to about 17,907 tons of tomato paste. The plant will be constructed in the South Hussinia Project Area.

Soybean processing: At the full development stage of the project, soybean oil of 4,110 tons and soybean cake of 16,223 tons will be produced from 21,630 tons of raw soybean. The soybean processing plant will be operated under the government control.

4.4.8. Marketing

The farm products in the Area will be on the market through an ordinary channel or a general distribution route which has been taken so far. Cabbage, cauliflower, and onion will be handled not only for domestic consumption but for export. West Germany, the Netherlands, England and Italy will be promising markets of these farm products. Canned tomato processed foods and frozen vegetables will be export-oriented products, particularly to the Arab nations. Beet sugar and processed dairy products will be promising in the domestic market as import substitutes.

4.5. Rural Development Plan

4.5.1. Layout of villages

Layout of the villages in the Project Area was contemplated as part of the wide area comprehensive development plan covering 240,000 feddan of the land area for the North and the South Hussinia Area and Southern Port Said Area. In the Project Area, 21 satellite villages will be established in the fundamental rural sphere, six service villages in the primary living sphere and two central villages in the secondary living sphere. About 315 settler farmers will live in the satellite villages. The Project will employ the clustered villages, which will be located possibly along the irrigation canals. A town should be developed in the North Hussinia Area as a core of the wide area living sphere.

4.5.2. Housing

At full development of the Project, about 60,000 people will settle down in the Area, and 12,000 houses by six types will be constructed. A housing lot ranging from about 200 m^2 to 300 m^2 will be offered for farm house with two bed rooms.

4.5.3. Infrastructure

There should be such infrastructure provided to meet the requirements of three village living sphere, as facilities for education, medical care, commercial activities, access, public utility, mosque, police station, fire station, post office, telecommunication, etc.

The Nile will be used as a water source for wide-area municipal water supply. A filtration plant should be established in the peripheral area of the town, having a daily maximum filtration capacity of 50,000 m^3, out of which 13,000 m^3 shall be supplied to the South Hussinia Area. Flushed toilets will be provided with those houses except for small scale farm households, and the sewerage treatment for those small scale farm households will be made by vacuum cars and intensive treatment in the public plant. This treatment plant will employ an oxidation ditch system and one plant will be provided in each village.

This has resulted from a comparative study with after system in terms of costs and function.

Electrification will be made in the best use of high voltage distribution line (220 KV) along the Suez Canal, and two substation will be constructed at the joint of the Suez and El Salam Canal, and the El Salam and Bahr Baqar so as to reduce the voltage to 11 KV. The distribution lines for 11 KV will be provided from these substations to the substations of the villages, pumping stations factories.

4.6. Physical Planning

4.6.1. Irrigation facilities

a. Irrigation canal

The irrigation system of the Project is topographically specified into the following three.

System-Wise Dimension of Irrigation Canal

Item		M1	M2	M3
Irrigation Acreage	(ha)	6,650	9,670	7,090
Total Length	(m)	89,900	131,770	101,420
Intake Water	(EL.m)	2.50	1.95	1.58
Maximum Intake Amount	(cu.m/s)	9.78	14.19	10.42

b. Main canal slope and gravity irrigation

The intake water level of the MI canal is higher than the elevations of the farm lands in the Ml irrigation system.

About 570 ha of the farm land along the M2 canal system and about 1,190 ha along the M3 canal system are located at higher elevation than the intake water level, and in further consideration of head loss, a considerable farm land would be irrigated by pumping system in this Project. When the canal slope is taken as steep as possible, the construction cost of pumping facilities will increase, although the canal construction cost will decrease.

This will result in rise of operation and maintenance cost of the pumping facilities as well. For successful physical planning of the irrigation facilities with optimum dimensions the alternative study was made for four cases with canal profile slope of 1/10,000, 1/15,000, 1/20,000 and 1/25,000 in respect to costs of canals construction, pumping facilities construction and necessary operation and maintenance.

The comparative study clarified that when taking canal slope for M1 main canal by 1/20,000, the entire farm land in the Area can be irrigated by gravity system with designed water level at El Salam Canal, whereas, for M2 and M3, the pumping facilities will be indispensable for effective irrigation. The more gentle slope the main canal may have, the less the pumping irrigation area may become and the more economical the operation and maintenance cost may become. Even if, however, the canal slope is taken by more than 1/20,000, the topographical conditions will prevent the gravity irrigation acreage from increasing, and therefore, there would be little difference in the annual cost required between the two cases with the slope of 1/20,000. In this planning, the main canal slope was designed by 1/20,000 in taking into account preciseness in construction works of gentle slope earth canal facilities and securing the discharge velocity as fast as possible. With this slope, the M2 canal system will command about 3,990 ha by gravity irrigation and the M3 canal system about 4,390 ha.

c. Lining of M1 main canal and on-farm pumping irrigation

Elevation of the area in the upper reach along the M1 main canal is comparatively low and the water level of the main canal is from EL 1.0 m to 2.5 m. And at the uppermost part, the embanked canal will be necessary for about 3.0 km long. For securing embankment stability, concrete lining should be executed for about 16,350 m long main canal.

An elaborate alternative study was made for lowering the water level in the main canal, which is expected to reduce the expensive lining cost. When taking the design water level by EL 1.00 m against the designed gravity irrigation water level of 2.50 m, the canal construction cost will be most economical in keeping well balanced share of earth cutting cost and embankment cost. In this case, however, about 325 small-size pumping facilities should be provided. The comparison of the annual cost shows that the cost of gravity irrigation will be 911×10^3 LE while $2,088 \times 10^3$ LE including expensive initial cost and renewal cost of pump facilities will be required for the case that the water level in the main canal is lowered.

d. Pumping facilities

As mentioned above, the M2 and M3 canal system will be provided with the pumping facilities with major dimensions as follows:

Major Dimensions of Pumping Facilities

Pumping Station	No. of Pumps	Type	Dia. meter(mm)	Lifting Capacity/ Unit (cu.m/min)	Total Lift(m)	Motor Capacity(kw)
M2 Main Station	6	Vertical Axial Flow Pump	1,200	200	1.5	75
M2-1 Two-step Station	4	"	700	69	1.5	30
M2-2 "	4	"	700	51	3.4	45
M3 Main Station	6	"	900	95	3.0	75

4.6.2. Drainage facilities

The Project Area will be drained to the existing Baqar drainage canal. Since the designed drainage water level is comparatively low for underground drainage, drainage pumping facilities should be adequately provided.

Major Dimensions of Drainage Canals

Kind	Total Length	Canal Capacity	Type
Main Drainage Canal	44,350	2.09 - 12.09	Earth Canal
Lateral Drainage Canal	251,200	0.05 - 1.59	"
Total	295,550		

As drainage pumping facilities, six units of pump, including one stand-by pump, will be provided by vertical mixed flow type with 1,200 mm diameter. The electric motors (260 KV x 6) also be used as prime mover in view of stability and easiness in operation. The maximum drainage capacity is expected at 14.18 cu.m/s.

About 29,000 feddan of swamps will be reclaimed by providing pumping facilities and main drainage canal between swamps and pumping stations so as to dry up the land, and in parallel with the main drainage canal, the lateral canals should be constructed.

Standard penetration tests ensured that construction machinery for marshes or ordinarily bearable land is operative in the area.

4.6.3. Land consolidation

The farm land owned by individual small-scale farmers is five feddan in acreage in a size of 210 m x 100 m. The typical layout of the farm plots is that five plots each should be located on both sides of the 1,050 m long on-farm irrigation ditch, and the total acreage of farm land in this layout is 50 feddan (21 ha). Such a farm block will be provided with 1,050 m long irrigation ditch and farm road, 1,050 m long drain and on-farm road, nine pipe drains with 85 m long for 10 farm plots, one diversion work from lateral canal and 30 intake notches from irrigation ditches.

4.6.4. Housing and public utilities

a. The number of houses to be constructed in the Project will be 9,359 in total throughout the Central villages, Service villages and Satellite villages, including 8,829 of farmers' houses, 22 of supervisors' residence, 22 of assistant supervisors' residence, 408 of engineers'/experts' residence and 78 apartment houses.

b. Public utilities

The proposed public utilities include three trunk roads with total length of 51 km, 18 community roads with total length of 82 km, one water filtration plant with capacity of 13,000 m^3/day, main and lateral delivery pipes of 128 km, 28 sewerage facilities, sewerage pipes with total length of 120 km, two substations and transmission lines with total length of 130 km, national telecommunication cable with total length of 20 km and local telecommunication line with total length of 180 km (total channels: 400 channels).

4.6.5. Farm products processing plants

A beet sugar plant, milk processing plants and tomato processing plant are proposed in the Project.

4.6.6. Project implementation

The Ministry of Reclamation, giving a main role to GARPAD, will be fully responsible for detailed design and implementation of the on-farm facilities including tertiary canals as well as other public utilities in close cooperation with other governmental organizations concerned, while the Ministry of irrigation for main and lateral irrigation and drainage canals.

The construction will be implemented on the contract basis. The most practical way of construction is to conclude the contract with a construction firm which has had relations with various governmental organizations concerned. The construction works should be started in 1988 when the El Salam Canal construction is completed and it takes six years for the project to be completed. Prior to starting implementation, two years will be necessary for loan negotiation and detailed design of the Project.

4.7. Construction Cost

Summary of Total Construction Cost - 1983 Price

(Unit: LE Million)

Items	Local Currency	Foreign Currency	Total
Reclamation Work	317.7	86.7	404.4
Housing & Public Utilities	200.3	64.6	264.9
Farm Products Processing	76.5	103.4	179.9
Total	594.5	254.7	849.2

The reclamation works can be divided into two stages, Stage I for providing open drains for underground drainage and Stage II for providing pipe drains to be replaced with open drains. The construction cost to be required for the reclamation is tabulated as follows:

Note: The Final Report was made using an annual price escalation rate of six percent for foreign currency and ten percent for local currency which have been estimated during this study. However, according to the updated estimate by OECF, JAPAN, the respective rates are five percent and 12 percent. Hence, in order to update the project cost, costs of escalation were revised using five percent for foreign currency and 12 percent for local currency.

Summary of Construction Cost of Reclamation Works

(Unit: LE Million)

	Local Currency	Foreign Currency	Total
Stage I Works (23,410 ha)			
Civil works	41,372	30,898	72,270
Others	11,641	11,191	22,832
Sub-total (Base Cost)	53,013	42,089	95,102
Physical Contingency	5,303	4,210	9,513
Price Escalation	34,216	16,093	50,309
Sub-total	39,519	20,303	59,822
Total	92,532	62,392	154,924
Stage II Works (23,410ha)			
Pipe Drains	58,991	14,183	73,174
Others	4,718	1,134	5,852
Sub-total (Base Cost)	63,709	15,317	79,026
Physical Contingency	6,370	1,531	7,901
Price Escalation	110,554	13,725	124,279
Sub-total	116,924	15,256	132,180
Total	180,633	30,573	211,206
Sum-total	273,165	92,965	366,130

5. Organization and Operation and Maintenance

The Project, which is a comprehensive development work, will involve many governmental organizations concerned for executing the works. The Project Executing Committee should be established by representatives from Ministries of Reclamation, Irrigation and Agriculture, and other authorities concerned for successful implementation. When the Project is completed, the facilities will be placed under the control of the related government agencies. It is proposed to provide an irrigation system office for effective and efficient operation and maintenance services of the facilities.

The irrigation system office will supervise three field offices which will give a helpful guidance to the farmers' organization in their practice of on-farm level water management.

6. Project Evaluation

6.1. Evaluation of Farm Land Reclamation Works

The economic annual incremental net production, which can be obtained by subtracting net production without project from net production with project, is expected to be LE 48.82 million in 2005. The financial project cost except for price escalation will be LE 191.55 million, economic project cost LE 165.86 million.

Economic internal rate of return (EIRR) was estimated at 13.0 percent taking 50 years as evaluation period and considering the allocation of El Salam Canal construction cost. The said EIRR, however, will be 15.4 percent without consideration of the above allocation. As a result, the Project can be found economically feasible.

6.2. Economic Evaluation of Farm Products Processing

6.2.1. Beet processing

In 2001, economic gross production value of beet processing will be LE 43.02 million, production cost LE 21.79 million and benefit LE 21.73 million, when taking the cost of raw materials by LE 30 per ton. The financial project cost of LE 89.5 million, excluding price escalation cost, can be evaluated by LE 85.4 million in economic project cost. The EIRR in these conditions was estimated at 19 percent in taking evaluation period by 30 years and the cost of raw beet by LE 30 per ton and estimated at 22.5 percent in taking the cost of raw beets by LE 20 per ton.

6.2.2. Milk processing

In 1997, the annual benefit of milk processing was estimated at - LE 0.5 million in taking the cost of raw milk by LE 0.3 per kg, at LE 2.37 million in taking the cost of raw milk by LE 0.25 and at LE 5.23 million in taking the cost of raw milk by LE 0.2. The financial cost of LE 6.3 million, excluding price escalation cost, can be evaluated by LE 5.6 million in economic cost.

The EIRR for the milk processing was estimated at - 1.0 percent, 16.5 percent and 37.5 percent for the cost of raw milk by LE 0.3, 0.25 and 0.2 per kg, respectively.

6.2.3. Tomato processing

The annual benefit of tomato processing factory in the year 2005 was estimated at 4.96 million LE in taking the unit price of raw tomatoes by LE 80 per ton. The financial cost and economic cost can be evaluated by LE 5.0 million and LE 4.58 million, respectively. Economic internal rate of return was estimated at 37.6 percent.

6.3. Economic Evaluation of Housing and Social Infrastructure

Feasibility of investments to municipal water supply, electrification, etc., although difficult in monetary evaluation, has been studied in a variety of methods by the World Bank.

6.3.1. Municipal water supply

If investment should not be made to the municipal water supply in the Project, there would not be a comparative study on the water supply system with daily capacity of 12,650 tons. The revenue by water charge has been used as economic benefit which is only approximation and conservative value available. As a result, the annual benefit of LE 0.46 million is expected by using 10 piastre per ton as most conservative value of benefit.

6.3.2. Electrification

In the case that investment is not made in power supply, 9,319,000 KWH of requirements for power in the Area will have to be supplied by diesel generation as alternative plan. The fuel cost difference between hydropower generation and diesel generation is considered as benefit by electrification. When the conversion factor of diesel oil cost is set by 1.01 (World Bank), the annual benefit from electrification was estimated at LE 0.8 million.

6.4. Economic Evaluation of Entire Project

1. Farm land reclamation .... EIRR: 13.0%

2. Farm land reclamation, housing and social infrastructure provision

   ° The case including benefits from water supply and electrification .... EIRR: 7.3%

   ° The case excluding benefits from water supply and electrification .... EIRR: 7.2%

3. The entire Project including farm land reclamation, social infrastructure, farm products processing.

   a. Raw materials: sugarbeet - 20 LE/ton, milk 0.2 LE/kg

      ° The case including benefits from water supply and electrification .... EIRR: 10.7%

      ° The case excluding benefits from water supply and electrification .... EIRR: 10.5%

b. Raw materials: sugarbeet - 20 LE/ton, milk 0.2 LE/kg, tomato - 80 LE/ton

° The case including benefits from water supply and electrification .... EIRR: 10.9%

° The case excluding benefits from water supply and electrification .... EIRR: 10.7%

6.5. Financial Analysis

6.5.1. Financial analysis of farm management

The financial analysis of farm management by three land-holding type of five feddan, 15 feddan and 20 feddan resulted in that even the small-scale farm households would obtain the economic surplus of about LE 1,500 at the full development stage in future and medium/large-scale farm households would gain so much economic surplus as to invest for reproduction and to save money. The yearly financial analysis of the farm households to be settled down after 1990 shows that the balance of farm economy of the settler farmers would vary from farmers, even in the same land holding level, by farm land soil qualities and it is expected to bring about some time lag for stabiligation of farm economy and difference in amount of preparation funds. Particularly special subsidy for credit condition for farm households with five feddan will be needed.

6.5.2. Repayment of construction cost

The foreign currency portion of the construction cost will be loaned by international finacing organizations, while the local currency portion will be borne by Government. In the reply to the GARPAD's comments to the Draft Final Report, the necessary annual repayment amount was estimated in certain conditions imposed.

6.6. Socio-economic impacts

In addition to the direct benefits, the Project will provide the indirect benefits as creation of employment opportunity, increase in tax revenue, expansion of consumers' goods market, income increase for local people during construction period, and saving a discharge of foreign exchange.

B. Conclusion

The aforesaid alternative plans have been proposed in terms of technology and economy so that the South Hussinia Valley Agricultural Development Project could be most successful as part of the Egyptian Government's long-term development programme. A variety of evaluations has come to a conclusion that the Project is economically feasible.

The Project will reclaim about 55,740 feddan (23,410 ha) into new farm land and about 88,000 people will settle down in the Area to live an improved life. The Project, therefore, will greatly contribute to nation's stable food supply through production increase.

C. Recommendations

1. The land reclamation project is technically sound and justifiable from the viewpoints of the national economy as well as private economy. It is, therefore, recommended that the Project should be executed in accordance with the proposed implementation schedule through the satisfactory financing.

2. Soils

   Intensive hydraulic conductivity tests should be made for the detailed design of on-farm drains, particularly on depth and spacing.

   For the swamp and inundated lands, the soil properties may be drastically changed by the desiccation works. Theretore, the hydraulic conductivity of soils should be measured after the desiccation.

3. Leaching Experiments

   The initial leaching requirements were estimated at 2,350 mm on an average in this report. However, laboratory leaching tests should be continued by GARPAD and the results should be used in the detailed design of the Project.

   Field leaching experiments should be commenced as early as possible by GARPAD to be ready for determination of leaching requirements in the detailed design.

4. Soil Improvement

   Soil improvement is essential to the agricultural development of the Project Area. The agricultural wastes, straws, animal litter should be reduced to the soils in the form of composite in order to improve both physical and chemical properties of soils.

5. Land Use

The land use of the whole area was projected including the existing arable land of about 7,800 feddans (comprising the fish ponds as a part of the land). Hence, the careful treatment of the existing farm households should be required to GARPAD for successful implementation of the Project.

6. Early Stabilization of Farm Management

The early stabilization of farm management by new settlers is most important to make a success in agricultural development. It is, thus, recommended to strongly take such an administrative policy as follows.

According to the study on the annual farm budget after settlement (Table F-27, Appendix), the negative balance of farm economy would continue for several years. In the initial stage of settlement, new settlers would require the loan to obtain the land, buildings, farm machines and production materials. The will have to prepare some cash funds to recover the negative balance in farm economy during the initial stage. Hence, the financial assistance by the Government is indispensable to early stabilization of farm management.

It is important that the production materials such as fertilizers, seeds and agro-chemicals are smoothly supplied to the new settlers.

Farm mechanization is essential for increasing the labor productivity. the operation and maintenance works of farm machinery should belong to the agricultural cooperatives. And operation schedule of farming machinery should be prepared by cooperatives. The settlers should establish the agricultural cooperatives immediately after their settlement in the Project

Area. Vegetable growers' groups should be established when vegetables can be successful grown in the Area. These cooperatives will market the agricultural products from the Project Area. In order to promote a successful activity of farmers' organization mentioned above, an intensive guidance by the agricultural extension office should be appropriately rendered.

It was planned that the water management on the on-farm level should be carried out in participation of all farmers. Consequently, the farmers' organization for water management should be established soonest after the settlement is completed in the Project Area under the control of the Ministry of Irrigation.

7. Rural Development Plan

The proposed capacity of the main facilities for the Project, i.e., water supply and electrification, is so designed as to meet the requirements including the North Hussinia and Port Said Project area. The rural development plan should be made up in due consideration ot the implementation schedule of the both Project Areas, accordingly.

CHAPTER I INTRODUCTION

CHAPTER I. INTRODUCTION

The Government of Egypt requested the Government of Japan to cooperate in promoting the South Hussinia Valley Agricultural Development Project in September, 1979. The Area is part of the land covered by the El Salam Canal Project which is now under way. The Government of Japan, in response to the request, has been positively extending technical and financial assistance in despatching the preliminary survey team and the feasibility study team in February through November, 1980. As a result, the final report of the feasibility study of the Project (hereinafter referred to as "the Phase I Project") was submitted to the Government of Egypt in March, 1981. Afterwards, the Government of Egypt requested the Government of Japan for cooperation in the development of the Project with cash crop cultivation, stockbreeding, agro-industrialization, and rural community development.

In February 1983, the Government of Japan, in response to the request, decided to study the South Hussinia Valley Agricultural Development Project Phase II (hereinafter referred to as "Phase II Project"). Consequently, the preliminary survey team and feasibility study team for the Phase II Project were despatched in July through August and in October through December, 1983, respectively.

The field report was presented to the Egyptian Government in November. The draft final report was compiled immediately after that toward the end of January, 1984 and was subsequently submitted to the Egyptian Government prior to the despatch of explanatory mission of the draft report from 25th January to 5th February, 1984.

1.1. This final report has been compilied on the basis of the following items agreed between the two governments.

1. Scope of Works and the revised Terms of Reference to be used as a guideline which were both agreed on 27th August, 1983 between the Egyptian Government representative Eng. Abdel Wahab Selim (GARPAD Director) and the Japanese Mission representative Mr. Kin-ichi Fujino.

2. Plan of Operation agreed on 20th November, 1983 between Dr. Samir Nagmoush, the Egyptian Government representative and JICA Feasibility Study Team Leader with attendance of JICA Supervisory Committee Mr. Kazumi Ueda as a witness.

3. Items confirmed on 29th November, 1983 between Dr. Samir Nagmoush and Feasibility study Team Leader with attendance as a withness of Eng. Abdel Wahab Selim and Mr. Kazumi Ueda.

4. JICA Feasibility Study Team presented the field report to GARPAD on 30th November, 1983. In response, the Egyptian Government made comments on the thirteen items for which the minutes were prepared by Dr. Samir Nagmoush and Feasibility Study Team Leader.

5. In compliance with the request of Egyptian Government, the Japanese Government despatched the explanatory mission of the draft final report from 25th January till 5th February, 1984. Final comments were submitted by the Egyptian Government on the respective fields of irrigation, rural development, soil, agriculture, and economic evaluation.

   With attendance as a witness of Eng. Abdel Wahab Selim, GARPAD Director, and Mr. Kin-ichi, Fujino, JICA Supervisory Committee Chairman, agreement was reached on 2nd February, 1984 between Dr. Samir Nagmoush and Feasibility Study Team Leader on the ways to deal with these comments.

Minutes concerning the above five items are attached in the Appendix-E of this final report.

1.2. Field Work:

(1) Collection and review of the relevant existing data and information

(2) Field survey and analysis including a variety of items such as soils, land use, irrigation and drainage, land reclamation, land disposal, agronomy, stockbreeding, agro-economy, agro-industry, regional economy and socio-demography, construction costs and marketing.

(3) Determination of the basic items for the Project planning

Home Work

(1) Overall agricultural development plan formulation
(2) Estimate of costs and benefits of the Project
(3) Economic evaluation
(4) Preparation of implementation schedule for the Project
(5) Planning operation and maintenance of the Project

1.3. Execution of Duty and Counterparts

The members of the supervisory group, the Feasibility Study Team (hereinafter called "the team") and the Egyptian Government officials contacted by the Team during the field survey are listed below;

Supervisory Committee Members

1. Chairman Mr. Kin-Ichi Fujino	Director of Integrated Rural Development Office, Land Improvement & Consolidation Division, Bureau of Agricultural Structure Improvement, Ministry of Agriculture, Forestry and Fisheries (MAFF)
2. Irrigation/Drainage Expert Mr. Hideki Kikuchi	Deputy Director of Disaster Prevention Division, Bureau of Agricultural Structure Improvement, MAFF
3. Soil Expert Mr. Yuji Goto	Specialist in Land Improvement/Environmental Control, Land Resources, Planning Division, Kanto Regional Administration Office, MAFF
4. Agro-economist Mr. Shogo Takemura	Chief of Project Planning Section, Bureau of Agricultural Structure Improvement, MAFF
5. Financial Specialist Mr. Hiroshi Takeuchi	Deputy Manager, 1st Division, Loan Department III, Overseas Economic Cooperation Fund (OECF)

Feasibility Study Team Members

1. Team Leader (Agro-Economy)	Mr. Shoji Yamada
2. Irrigation and Drainage	Mr. Kunio Ohta
3. Soil	Dr. Shiro Terasawa
4. Soil	Dr. Naruwo Kondo
5. Soil	Mr. Kazuo Nakabayashi
6. Agriculture & Agro-industry	Mr. Hirokazu Kouriki
7. Stockbreeding & Agro-industry	Mr. Kensuke Iriya
8. Community Development	Mr. Yoshihiko Nishikawa

Egyptian Government Officials Contacted by the Team

I. General Authority for Rehabilitation Project and Agricultural Development of the Ministry of Land Reclamation (GARPAD, MOLR)

1.	Mr. Abdel Wahab Selim	Chairman
2.	Mr. Maher Bahaa El Din	Vice Chairman
3.	Mr. Zaki Arnaaut	Director of Planning & Follow-up Sector (MLR)
4.	Dr. Samir Nagmoush	Technical Counsellor
5.	Dr. Rifki Anwar	Technical Counsellor
6.	Mr. Ahmed Fahmy	Technical Counsellor
7.	Eng. Yussif Amin	Technical Counsellor
8.	Eng. Mohamed Badr El Din Hatez	Economics and Agriculture (Counterparts)
9.	Eng. Salah Raslan	Coordinator for F/S Team
10.	Eng. Fathalla Shaker	Agro-Industry (Counterparts)
11.	Eng. Mohamed Ryhan	Irrigation (")
12.	Eng. Samir Naguib	Animal Breeding (")
13.	Eng. Goma El Azazi	Soil (")
14.	Eng. Mohamed Sowelam	Rural Development (")
15.	Mr. Hassan Ab El Nasr	General Manager, Civil Eng. Dept.
16.	Dr. Fayez S. Hanna	Soil Scientist
17.	Eng. Galal El Misidi	Director of Laboratory
18.	Eng. Mahmoud Fahmay	General Director of Agriculture Dept.
19.	Eng. Salled Zahran	General Manager of General Department of Plant Production
20.	Eng. Mahamed Hagrus	Director of Horticulture Dept.
21.	Mr. Hahmoud Hamdi Khadr	Agro-horticulture
22.	Mr. Emad El Deen Ibrahim	Animal Breeding
23.	Eng. Mohemed Ebrahiem	Staff of Agriculture Department
24.	Eng. Abdedymn Ahmady	Staff of Laboratory
25.	Ms. Elham Hamdi El Khamly	Agro-economist
26.	Ms. Oohair Amien	Chairman's Office
27.	Ms. Nazli Ali	Chairman's Office

II. Ministry of Irrigation (MOI)

1. Eng. Morris Kamel	First Undersecretary
2. Eng. Helmy Mahmoud Ibrahim	Technical Secretary-Sector Project, Expansion

CHAPTER II GENERAL DESCRIPTION

CHAPTER II. GENERAL DESCRIPTIONS

2.1. Project Area

2.1.1. Location and Road System

The Project Area of 74,700 feddan or 31,400 ha is situated in the northeastern portion of the Nile delta. The Suez Canal runs about 25 km east of the Project Area. Cairo, the capital of the Arab Republic of Egypt (ARE), is situated about 150 km southwest of the Project Area. Zagazig, Ismailia and Port Said are 75 km, 90 km and 45 km away from the Project Area respectively.

A national road runs to Cairo from San El Hagar which is situated in the westernmost part of the Project Area. From this national road, an unpaved road branches off, and runs along the Bahr Baqar drain as it surrounds the southern and eastern portions of the Project Area.

There are no community roads nor farm roads in the Project Area. The only paths are those made by tractors transporting salts gathered from the lakes.

Around the Project Area, there is an operation and maintenance road running along the Bahr Baqar, the eastern border of the Area, but this is an earth paved road four to five meters wide.

Along part of the Bahr Saft drain, the western border of the Area, there is an earth paved road two to three meters wide.

2.1.2. Population and Living Conditions

The Project Area is situated in Sharkia province, and San El Hagar is located in the western edge of the Project Area. This village was established some ten years ago under the land reclamation and settlement program of the Government of ARE, and has functioned as a service village for the Project Area and its neighborhood.

The estimated population is about 50,000 persons living in the vicinity of the Project Area. San El Hagar is the most densely populated place in the area.

2.1.3. Topography and Rivers

There is a total of about 7,800 feddan of cultivated lands in the Project Area, and submerged lands account for about 27,600 feddan. The Project Area has a gentle slope of about 1/5,000 to 1/10,000 towards the northeast, and is topographically divided into two portions, that is, the northern plain represented by submerged lands and the southern hilly area with an elevation of one to three meters in general.

The Damietta branch, a tributary of the Nile, El Salam Canal, Bahr Hadous, Bahr Saft drain, and Bahr Baqar are the related rivers and canals to the Project Area.

The Bahr Hadous drain is one of the main drains in the East Delta. It has a catchment area of about 2,300 sq.km, and the annual discharge recorded at about 3,000 MCM. It has a salinity of 1,200 to 2,700 PPM and a sodium absorption rate of 12 to 22, the canal water is useable only for irrigation purposes, even if diluted with fresh water. However, it could be directly utilized for the initial stage of leaching.

2.1.4. Meteorology and Hydrology

a. General Meteorology

The Project Area has no weather station, therefore, weather data for the past ten years (1969-1978) recorded at the El Mansoura station have been selected for the study.

The mean annual temperature is a moderate 20.4°C. The mean monthly temperature in January is the lowest throughout the year, and it stands at 12.6°C. The minimum daily temperature of 6°C is particularly low. The mean annual rainfall is about 50 mm, and about 50 percent of this falls in December and January. The mean figures of each items during 10 years are shown in the following table and illustrated in Figures II-1 and II-2.

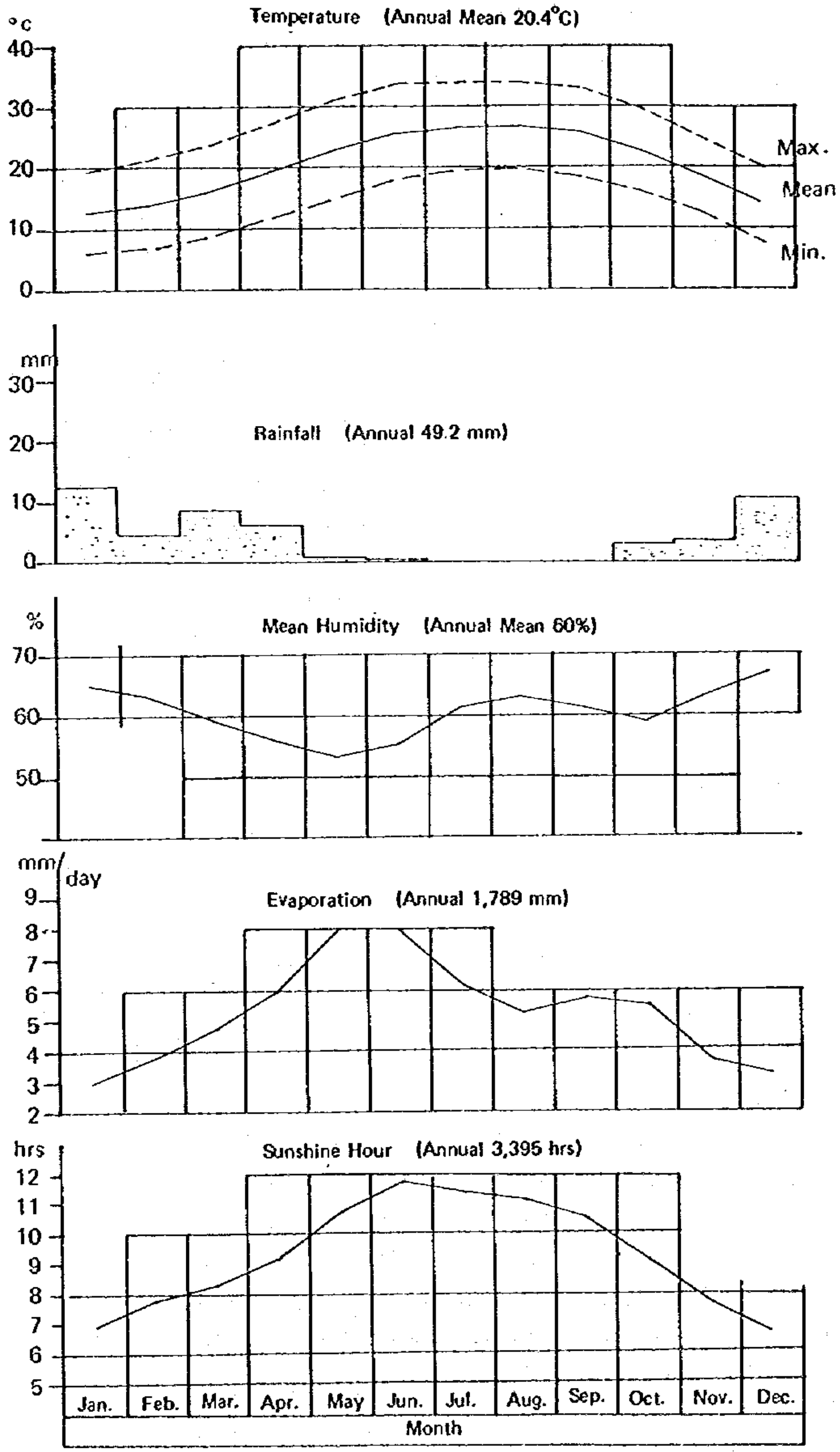
	Jan.	Feb.	Mar.	Apr.	May	Jun.
Mean Min. Temperature (°C)	6.0	6.5	8.4	11.4	14.8	18.2
Mean Temperature (°C)	12.6	13.7	15.9	19.2	23.0	26.0
Mean Max. Temperature (°C)	19.2	20.9	23.5	27.0	31.1	33.9
Mean Humidity (%)	65	63	59	56	53	55
Mean Rainfall (mm)	12.3	4.2	8.5	6.0	0.4	0.2

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Mean Min. Temperature (°C)	19.7.	19.7	18.3	15.8	12.4	7.8	13.3
Mean Temperature (°C)	26.9	26.8	25.6	22.7	18.6	14.0	20.4
Mean Max. Temperature (°C)	34.1	33.8	32.9	29.6	24.8	20.0	27.6
Mean Humidity (%)	61	63	61	59	63	67	60
Mean Rainfall (mm)	0.0	0.0	0.0	3.3	3.6	10.7	49.2

b. Hydrology

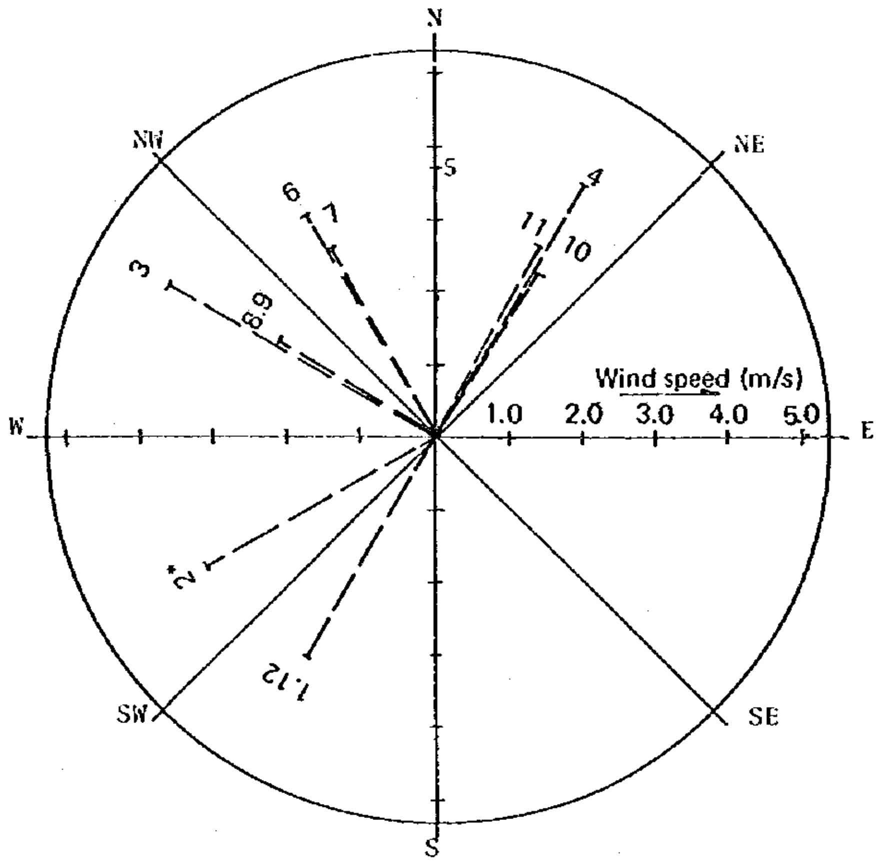
Drains and canals related to the Project Area are the five courses mentioned previously inclusive of El Salam Canal. Most of these drains and canals are affected by the Nile. Since the operation of barrages, pumping stations and main branch canals are made on a water distribution program, the fluctuation of discharges and water tables is very small if any.

Figure II-1 Meteorological Conditions



Station: El Mansoura, Observation Period: 1969 to 1978

Figure II-2 Wind Direction and Speed



Station: El Mansoura

Observation period: 1969 to 1978, 10 years

Note: * Month 1–Jan., 2–Feb., ...

The basic plan for El Salam Canal Project is that, out of the monthly discharge of 237 MCM/month, 35 MCM/month (or percent of the averaged discharge or about 50 percent of the monthly discharge in February) will be diverted for recycling use in the first stage whereas about 220 MCM/month (93 percent of the averaged discharge) in the final stage.

Bahr Saft drain has the annual average discharge of about 740 MCM/year which is converted to 63 MCM/month. In February, the monthly discharge decreases to one-fifth to one-third of the monthly average discharge throughout the year.

Bahr Baqar drain has the annual average discharge of about 1,380 MCM/year which is converted into the monthly average of 115 MCM/month.

Due to the absence of the observation data of discharge in Ramses drain, detailed information on this drain is not available. In this study, the discharge capacity of this drain is estimated at 6 cu.m/sec.

2.1.5. Agriculture

The major summer crops in the Sharkia governorate involving the Project Area are cotton, paddy and maize. On the other hand, berseem and wheat are the main winter crops in this area. The total area under cultivation with these five crops grown in a three-year rotational cropping system accounts for more than 80 percent of the total cropping area with a cropping intensity of about 190 percent.

The Sharkia governorate is one of the most important cereal producers of the country. The annual cropping acreages of the so-called "five major Egyptian crops", that is, cotton, paddy, berseem, maize and wheat in the governorate have accounted for a certain percentage between 10 and 17 percent of the national total cropped acreage of each crop for the past five years and more.

The average yield of most vegetables in the Sharkia governorate has been almost the same or more than the national average.

More than 70 percent of the cows bred in Egypt are presumably owned by small farmers and are used in farming as well as for production of milk and meat. The number of cows and buffaloes in the Sharkia governorate in 1981 was reported to be about 256,000 and 221,000, respectively.

There are three types of services for farm machinery operation available for small farmers: group operation services, cooperative operation services and governmental operation services.

2.1.6. Irrigation Conditions

Farm lands extend along the Bahr Saft drain on the western border, along the existing canal on the southern border and along the Bahr Baqar drain on the eastern border of the Project Area. Part of area located along the Bahr Baqar drain includes fishponds.

The farm lands along the Bahr Saft drain were reclaimed by individual farmers more than 15 years ago. Some of these lands have become cultivable in many respects so that they can harvest crops at the same levels as those existing farm lands around the Project Area. These farm lands are cropped with paddy, cotton and maize in the summer season, while wheat, vegetables and berseem (Egyptian clover) are grown in the winter season.

The irrigation water source of these lands is the Bahr Saft drain, from which water is taken by the gravity system into the irrigation canals provided in the fields and conveyed to the plots through the terminal facilities after being lifted by small-size pumps called "Sakkia" which are operated by draft animals.

2.1.7. Drainage Conditions

The drainage conditions in the Project Area are extremely unfavourable, and 27,600 feddan, which is equivalent to about 37 percent of the total, is submerged land. The water level in submergence has fluctuated in a range from WL 0.0 to 0.5 m against the elevation of submerged areas below EL 0.25 to 0.5 m. Besides, the submerged areas, extending very flat, vary in acreage with fluctuations of the water level of the Lake.

The water intrusion from the Manzala Lake will be completely stopped by the embankment of the El Salam Canal that is now under construction by the Ministry of Irrigation.

The hilly lands not suitable for cultivation developing from south to west in the Project Area provide several depressions below EL 0.25 m, into which highly concentrated salty groundwater (about 30 percent of salinity concentration) has been flowing from the peripheral areas.

The newly reclaimed lands around the Area are drained by pumps, which can control the groundwater table so as to prevent the soils from salt accumulation caused by shallow groundwater. The water level of these drainage canals is kept at about one meter below ground surface at the terminal field drains.

2.1.8. Field Conditions

The Project Area is surrounded by developed farm lands, for which intensive land consolidation with land levelling has been implemented. The respective field plots are rectangular having a length of 150 - 200 m and width of about 100 m, and the irrigation canals are provided separately from the drainage canals.

The surface irrigation is dominant in these farm lands and no sprinkler irrigation nor drip irrigation has been observed. In the fields, farm drains have been provided at about 20 m interval so as to carry out leaching for salt elimination.

2.2. Economic Development Plan

The new Five Year Plan for Economic and Social Development 1982/83 to 1986/87 has been in effect since 1982.

2.2.1. Production

The plan aims at an eight percent increase in average annual production. The sectoral growth rates are 8.4 percent for the commodity sectors, eight percent for the social services sector and 6.8 percent for the production service sectors. The most of the forecasted increase in national production (65.3%) is to originate in the commodity sectors.

2.2.2 Gross Domestic Product

The plan aims at an average annual rate of the increase of GDP of 8.1 percent. Table II-1 shows GDP by sector.

Table II-1. Gross Domestic Production

Sector	Target 8/83	Target 86/87	Annual Increase Ratio 82/83 / 81/82	Annual Increase Ratio 82/83	Share 82/83	Share 86/87
	Million L.E (1981/82 price)		%	%	%	%
Commodities	11,585	15,837	9.8	8.5	54.3	54.8
Agriculture	4,000	4,660	2.8	3.7	18.8	16.1
Productive Service	5,704	7,598	6.0	7.2	26.8	26.2
Social Service	4,027	5,486	8.5	8.1	18.9	19.0
Total	21,316	28,921	8.5	8.1	100.0	100.0

2.2.3. Population and Labor

The supply of labor force is determined in large part by the size and structure of population. The following interim projections of population were made.

1985	47.7 million
1987	50.5 million
1990	53.8 million

The Egyptian labor forces constitute 31 percent of the total population, and is growing at an average annual rate of 2.2 percent. Although the rate of growth of the female labor force is higher than the corresponding rate for male, participation by females in the total labor force is very limited (less than 10%).

Agriculture still holds the first place in labor force absorption. Although the relative position of the agricultural labor forces has been on the decline since 1937, it still represents 44 percent of the labor force in 1976.

The plan aims at providing new jobs for about 2.1 million workers, at an average rate of 420,000 workers every year. The plan puts special emphasis on increasing employment in the commodity sectors.

Table II-2. Development of Total Employment Over 1981/82 - 1986/87

(Unit: 1,000 LE)

Sector	1981/82	1986/87
Agriculture	4,247.5	4,738.0
Mining	39.5	46.1
Manufacturing	1,423.2	1,863.2
Oil and Oil Products	24.5	28.1
Electricity	64.2	80.9
Construction	664.1	912.0
Total Commodity Sectors:	6,463.0	7,668.3
Total Productive Services Sectors:	1,781.9	2,167.1
Total Social Services Sectors:	3,480.0	4,001.4
Grand Total	11,724.9	13,836.8

2.2.4. Regional Development Strategy

Regional development strategy in general aims at mitigating regional differences in every aspect. In the specific conditions of Egypt, regional development strategy aims at overcoming the dualism of the economy, i.e. the widening gap between urban and rural areas.

Development policy in the rural regions should be concentrated on the following matters.

- The modernization of agriculture
- Expansion of the cultivable land through reclamation of the desert lands as well as through conservation of existing fertile lands
- Diversification of activities by introducing new occupations apart from agriculture in order to create a better economic structure in the rural regions
- Improving agricultural incomes in order to weaken the incentive to switch from agriculture to other activities to earn higher income

2.2.5. Delta Region Development Strategy

The Delta is mainly an agricultural area. Major problems of agriculture development are traditional farming methods, small and scattered land holdings, poor soil fertility, declining returns on some main crops such as cotton and rising production costs due to wage increases.

In order to tackle these problems, the plan aims at:
Introducing new farming techniques comprising mechanization and improved cropping according to land qualities and availability of water.

- Improvement and expansion of irrigation and drainage networks.
- Introduction of new crops such as soybeans and sugarbeet which will attract new agro-industries and create more work opportunities
- Directing efforts to reclaim more land in the northern part of the region
- Encouraging major industrial activities such as textiles, food and fertilizer production.
- Introducing new processing industries fodder and sugarbeet and expansion of the clothing industries, for which credit will be made available through the Industrial Development Bank
- Improvement of infrastructure with high priority given to plans to attract more investment and industry into the region

CHAPTER III LAND RESOURCES

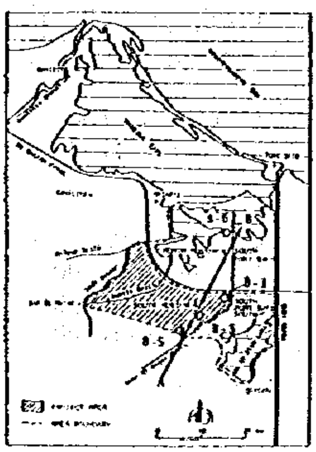
CHAPTER III. LAND RESOURCES

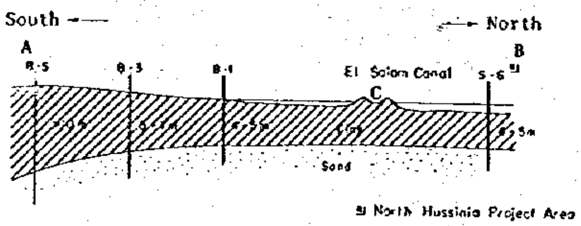
3.1. Natural Environment

The Project Area of 74,700 feddan in total is located in the northeastern edge of the Nile Delta, and is mainly composed of flat plain including swamps and inundated area, and has a gentle slope towards northeast.

The climate of the Project Area is characterized by its hot and dry summer, that is, the "dry, hot desert" category in the Koppen's classification system. According to the Soil Taxonomy's definitions, the moisture and temperature regimes of the Project Area soils fall into "torric" and "termic" categories, respectively. In the swamp and inundated area, on the other hand, the soil moisture regimes fall into the "aquic (per-aquic)" category.

The Project Area is composed of Quaternary fluvio-lacustrine deposits which are fine textured and recent origin. Through the sedimentation of materials tranpsported by the Nile River, fine or coarse deposits have been stratified alternately in the profiles. Generally, clay or silty clay layer overlies the sandy substratum at varrious depth. Many shell fragments are contained at five to seven meters below the surface in some portions. These shell-rich layers prove that they are situated on the former beach line. The thickness of overlying clay or silty clay layers shows the general tendency of decreasing towards the Manzala Lake, as shown below;





Geomorphologically, the Project Area as a whole is composed of the fluvio-marine marshes (clay swamps and clay flats), the clayey plains, and the medium-high clay dunes. Figure III-1 shows the geomorphology and land slope classification of the Project Area. The acreage of each land slope class is shown bellow;

Class	Slope (%)	Area (feddan)	Area (%)	Geomorphology
1	0.1	31,310	41.9	Fluvio-Marine Marshes
2	0.1 - 0.2	14,190	19.0	- Clay Swamps
3	0.2 - 0.3	20,740	27.8	- Clay Flats
4	0.3 - 0.5	6,600	8.8	Plains
5	0.5 - 1.0	1,310	1.8	- Clayey Plains
6	1.0	550	0.7	Windblown Deposits - Medium - High Clay Dunes
	Total	74,700	100.0	

The fluvio-marine marshes (clay falts and clay swamps) occupy about 90 percent of total area and the clayey plains occupy the southern fringe of the Project Area of which elevation is higher than other portions.

Quality of the flowing water fluctuates widely in relation to the discharge rate at the measuring time. In general, the concentrations of total soluble salts can be summarized as below;

	Total Soluble Salts (ppm)
Flowing Water	
° Drain water (Bahr Hadous, Bahr Saft, Ramsis, Bahr El Baqar)	1,200 - 2,700
° Nile river water (Downstream)	700 - 1,000
Stagnant Water	
° Lake Manzala	about 2,000
° Fish Ponds	4,000 - 8,000
° Depressions	10,000 - 150,000
Groundwater	20,000 - 150,000

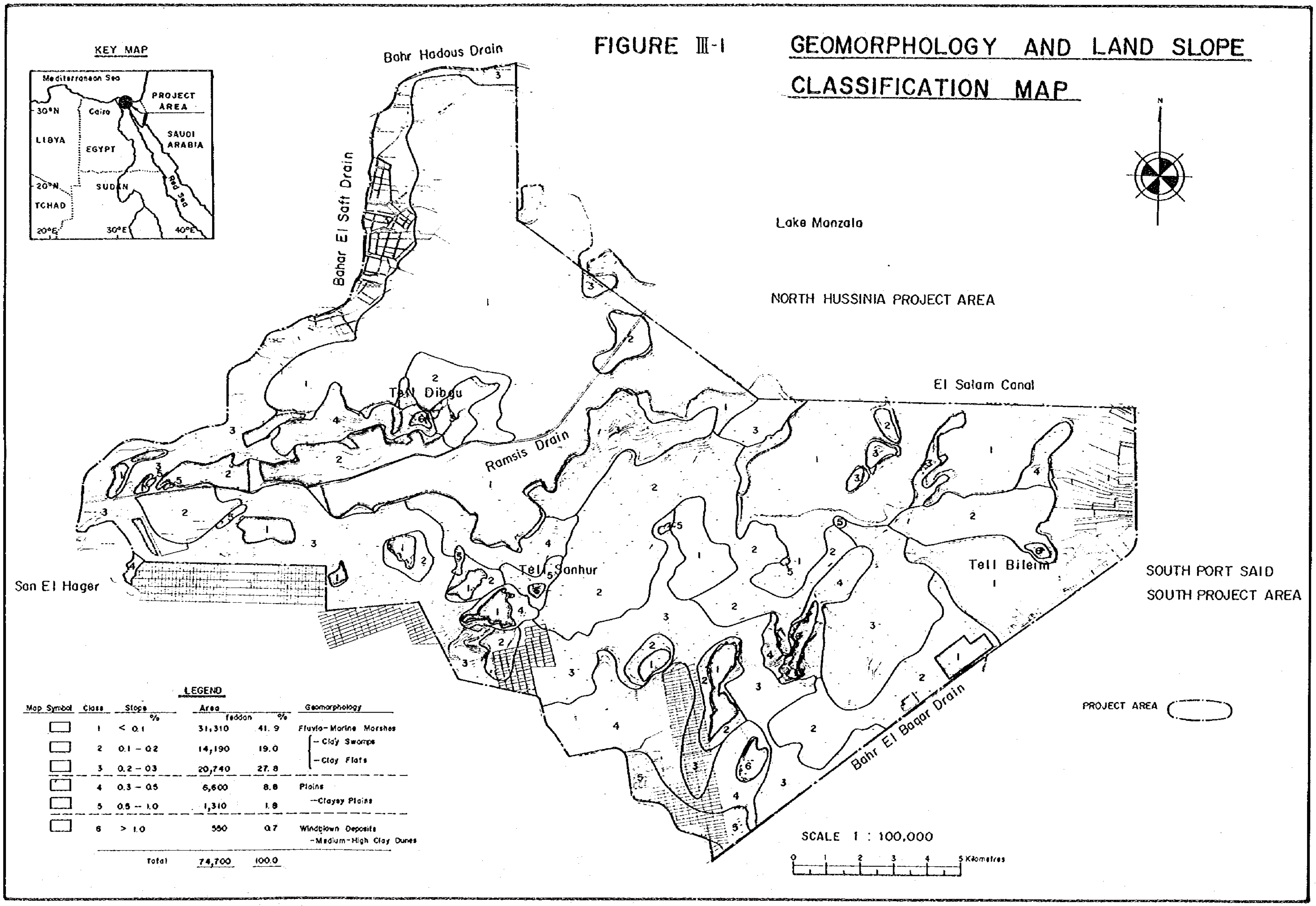


FIGURE III-1 GEOMORPHOLOGY AND LAND SLOPE CLASSIFICATION MAP

LEGEND

Map Symbol	Class	Slope %	Area feddon	Area %	Geomorphology
☐	1	< 0.1	31,310	41.9	Fluvio-Marine Marshes
☐	2	0.1 – 0.2	14,190	19.0	– Clay Swamps
☐	3	0.2 – 03	20,740	27.8	– Clay Flats
☐	4	0.3 – 0.5	6,600	8.8	Plains
☐	5	0.5 – 1.0	1,310	1.8	– Clayey Plains
☐	6	> 1.0	550	0.7	Windblown Deposits – Medium-High Clay Dunes
		Total	74,700	100.0	

The stagnant water of depressions as well as the groundwater include total soluble salts at extremely high level.

Because of the water scarcity as well as soil salinity, natural vegetation is limited to peripheries of the swamps and inundated areas where the species of Salicornia and Phragmites are grown predominantly. The vast clay flats are barren and only the zerophytic shrubs, Tamarix sp. are grown on the foot of low clay dunes. The Phase I Report mentioned that there was no active agriculture at that time, except for farm lands of about 6,000 feddan in total along the Bahr Saft drain and the southern fringe of the Project Area. The present survey has revealed the extention of agricultural activities along the drains, especially along Bahr El Baqar, Ramsis, Bahr Saft, and Bahr Hadous drains. In addition, the Project Area includes two reclaimed areas executed by the government, that is, the Taimoor and the Hanon projects.

The present land use in the Project Area is shown in Figure III-2.

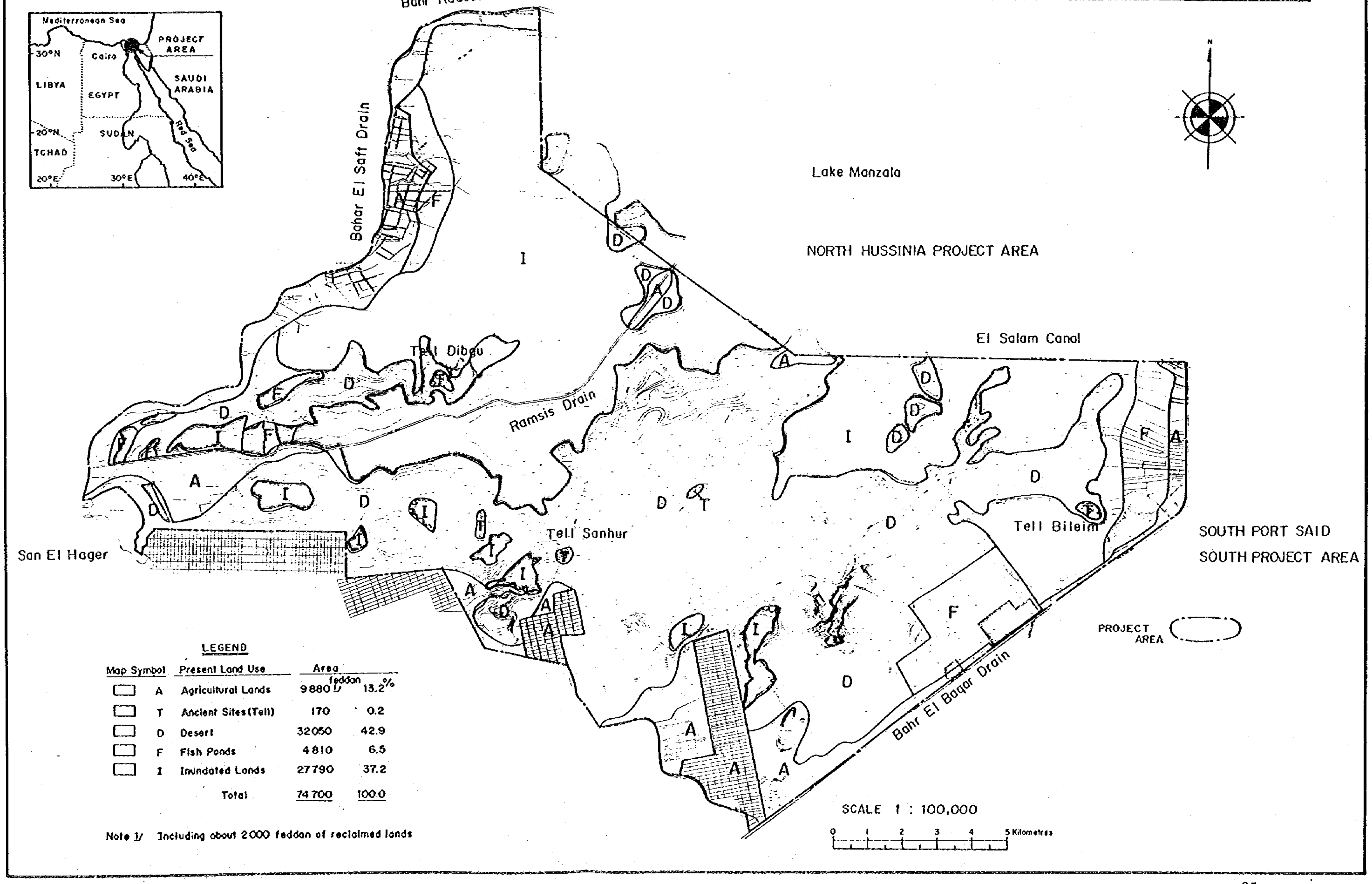
Present Land Use	Area (feddan)	Area (%)
Agricultural lands	7,800 1/	10.5
Ancient Sites (Tell)	370	0.5
Desert	34,080	45.6
Fish Ponds	4,810	6.5
Inundated Lands	27,560	36.9
Total	74,700	100.0

Note: 1/ Including about 2,000 feddan of reclaimed lands.

3.2. Objective and Methods of Soil Survey

The soil survey in the Phase II Study was carried out during the period from October 15 to December 4, 1983 in order to supplement the Phase I Report (1981) and to obtain the sufficient information to classify the drainability and reclaimability of Project Area soils.

FIGURE III-2 PRESENT LAND USE MAP



In order to assess the drainability and reclainability of the Project Area, systematic soil profile investigation was made to identify the permeable and impermeable layers as well as hydraulic conductivity measurement. Another aim of the study was to adjust the principle of classification systems with the ongoing North Hussinia and South Port Said Project.

The soil survey was composed of the following studies;

- Soil profile investigation
- Hydraulic conductivity measurement
- Laboratory analysis
- Leaching experiments
- Clay mineral identification
- Geotechnical Survey (Deep boring)

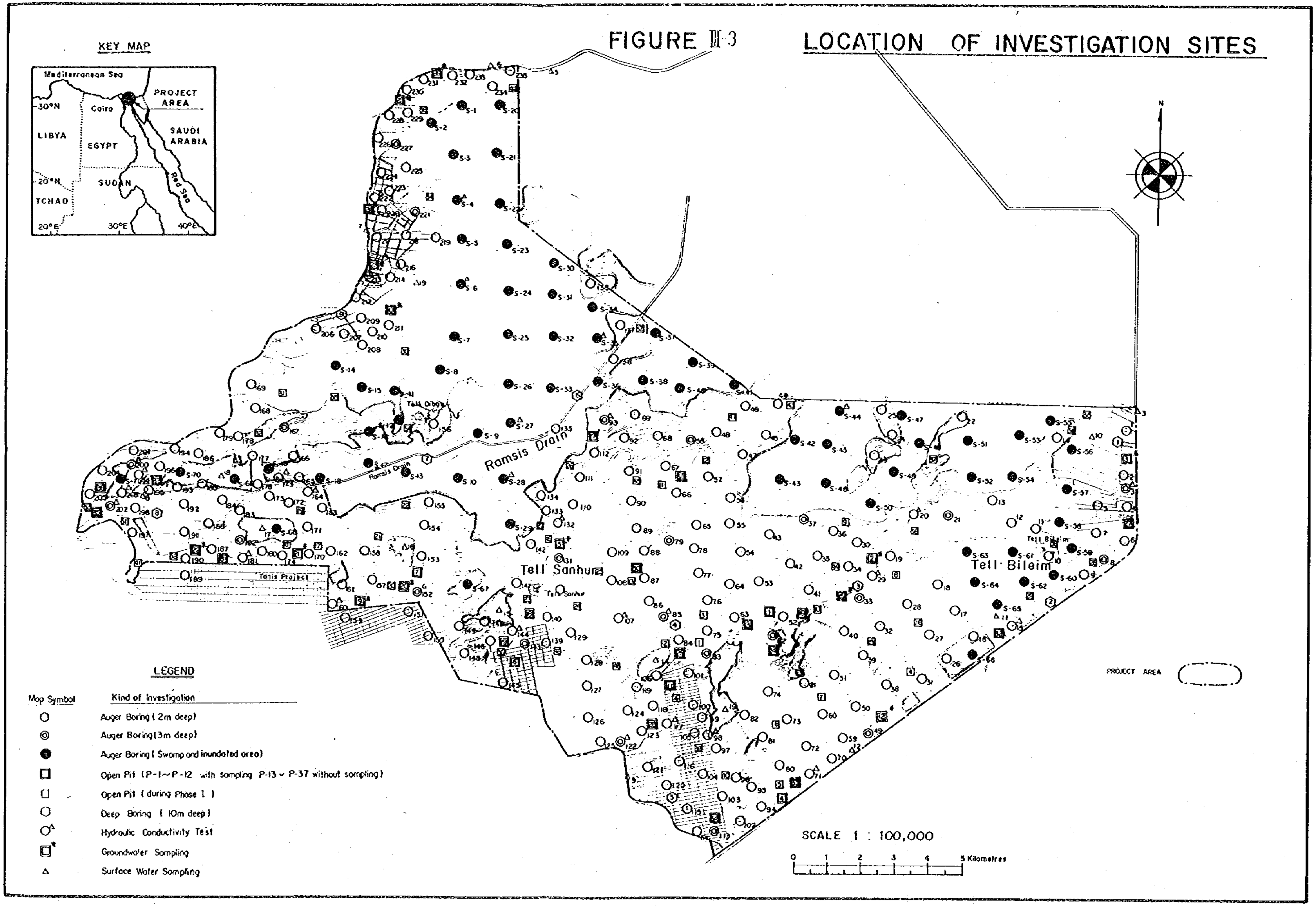
The location of the soil profiles investigation is shown in Figure III-3.

3.3. Soil Classification

In the World Soil Map scaled 1:5,000,000 compiled by FAO/UNESCO, the Project Area as a whole is covered with Gleyic Solonchaks.

In the Phase I study, the Project Area soils were classified into three soil series which had been used in the High Dam Soil Survey Project (FAO 1963), that is, Clay Swamp (Ms), Port Said (Ps), and Manzala (Ma) series. This system was based on actual drainage status, reflected in the depth to groundwater table which is closely related to the land elevation. Each series was further subdivided into soil types according to the properties such as degree of salinity, reflected in visual features of the surface (salt crust, puffy-structure etc.), and texture.

FIGURE III-3 LOCATION OF INVESTIGATION SITES



These soil series correspond to the following families of subgroups in the Soil Taxonomy system. Which was used in the present study.

Clay Swamp series (Ms): very-fine clayey, montomorillonitic, thermic family of Sulfic Hydraquents, or fine clayey, montmorillonitic, thermic, family of Typic Salorthids

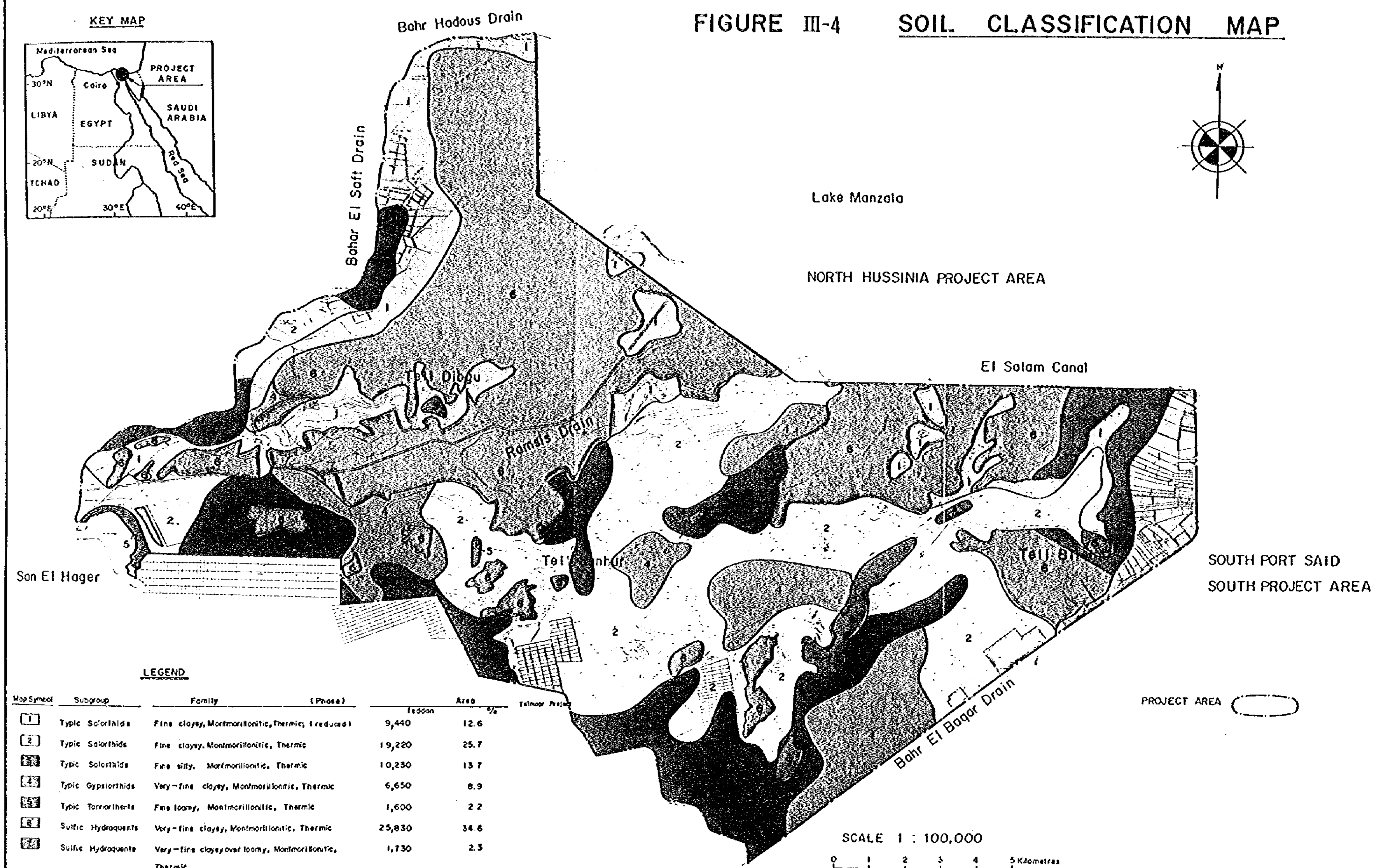
Port Said series (Ps): fine clayey, montmorillonitic, thermic family of Typic Salorthids, or very-fine clayey montmorillonitic, thermic family of Typic Gypsiorthids

Manzala series (Ma): fine-loamy, montmorillonitic, thermic family of Typic Torriorthents

In the present study, the Project Area soils were classified in accordance with the system described in the Soil Taxonomy by the USDA. In principle, the system classifies the soils depending on the presence of diagnostic horizons. The Great Groups found in the Project Area are Salorthids, Gypsiorthids, Torriorthests and Hydraquests. Figure III-4 shows a soil classification map of the Project Area, and the acreage of each mapping unit is as shown below;

Subgroup	Family	Area (feddan)	Area (%)
Salorthids	Fine Clayey, Montmorillonitic, Thermic; (reduce)	9,440	12.6
Salorthids	Fine Clayey, Montmorillonitic, Thermic	19,220	25.7
Salorthids	Fine Silty, Montmorillonitic, Thermic	10,230	13.7
Gypsiorthids	Very-fine Clayey, Montomorillonitic, Thermic	6,650	8.0
Torriorthent	Fine Loamy, Montmorillonitic, Thermic	1,600	2.2
Hydraquents	Very-fine Clayey, Montmorillonitic, Thermic	25,830	34.6
Hydraquents	Very-fine Clayey over Loamy, Montmorillonitic, Thermic	1,730	2.3
	Total	74,700	100.0

FIGURE III-4 SOIL CLASSIFICATION MAP



LEGEND

Map Symbol	Subgroup	Family (Phase)	Area Feddan	Area %
1	Typic Salorthids	Fine clayey, Montmorillonitic, Thermic (reduced)	9,440	12.6
2	Typic Salorthids	Fine clayey, Montmorillonitic, Thermic	19,220	25.7
3	Typic Salorthids	Fine silty, Montmorillonitic, Thermic	10,230	13.7
4	Typic Gypsiorthids	Very-fine clayey, Montmorillonitic, Thermic	6,650	8.9
5	Typic Torriorthents	Fine loamy, Montmorillonitic, Thermic	1,600	2.2
6	Sulfic Hydraquents	Very-fine clayey, Montmorillonitic, Thermic	25,830	34.6
7	Sulfic Hydraquents	Very-fine clayey over loamy, Montmorillonitic, Thermic	1,730	2.3
		Total	74,700	100.0

3.3.1. Soils of Dry Lands

The salt accumulation in the surface soils is a principle pedogenic process, and Prominant features of the soils prevailing in the dry land areas are summarized as below;

1. Thick Montmorillonitic clay layer beneath a thin wind-blown silt

2. Salt accumulation on the surface and/or in the surface layer by capillary upward movement of saline groundwater under high evaporation

3. Strongly cemented subsoil

4. Gypsum rich-layers in various form

The soils of dry lands were classified into three Subgroups, that is, Typic Salorthids, Typic Gypsiorthids, and Typic Torriorthents.

a. Typic Salorthids

About 80 percent of dry land area were classified into Typic Salorthids (38,890 feddan, corresponding to a half of total Project Area) because of having a salic horizon. Typic Salorthids are very saline soils formed on somewhat wet protions in the desert where capillary upward movement and evaporation of water accumulate salts into a salic horizon. The accumulation of salts is within 75 cm below the surface, and usually it is very near the soil surface.

Commonly, there is a saturated zone by capillary water. If the groundwater table is shallow, the water moves upward through capillary spaces and reaches the surface. The dissolved salts precipitate owing to the evaporation of water at the surface. When the salt precipitate at the soil surface, white salt crusts are formed. In the depressions where the groundwater table is very shallow and the saline water gathers from the surrounding areas, the thick hard salt crusts (2 - 3 cm thick) cover the surface, and numerous fine white salt crystals (NaCl) are found in the surface soils. In the slightly higher portion than the depressions, the fluffy structure including many fine needle-like crystals are found just below the surface.

The salts fill the fine pores and pressed the soils particles when crystaling consequently the soil structure swollen to be fluffy.

The chemical analysis showed that ECe values of most soils ranged from 16 to 64 mS/cm. The texture is predominantly montmorillonite clay and silty clay, but coarse texture is found in some portions. These soils contain a little organic matter. The structure development is very weak.

The groundwater saturate soils at some times of the year in some subhorizone within one meter of the surface. As the result, soil profiles show the gleization due to the reduction status at various depth depending upon the groundwater table. These soils hold the water at relatively lower tension, however, the high osmotic pressure due to the dissolved salts makes the soils physiologically dry. In some subhorizons, moreover, strongly, comented layer has been formed. All of these factors restrict the soil drainability.

Note: The Phase I Report has made the detailed descriptions of general features of dry land soils, therefore, those which mentioned in the phase I Report are omitted in this report in order to avoid repetition.

At present, small portions of these soils are used for agricultural lands where rice and berseem are mainly cropped. On low-lying lands near swamp and inundation area, salt tolerant plants, Salicornia Cheropodium and Tamarix Nilotica Ehrenb are growing. However, vast clay flats are nearly barren because of high salinity of these soils. Only dwarf Tamarix Nilotica Ehrenb grow sparsely.

These soils were subdivided into families by their particle-size, mineralogy, and soil temperature classes as below;

° Fine clayey, montmorillonitic, thermic[1/]
° Fine silty, montmorillonitic, thermic

b. Typica Gypsiorthids

A gypsic horizon containing a large amount of gypsum ($CaSO_4$ $2H_2O$) in various farms was identified in some very-fine clayey soils. Because of the gypsic horizon as a diagnostic horizon of which upper boundary was found within one meter from the surface, these soils were classified as Typic Gypsiorthids. Mostly, they are found in the slightly depressed areas and occupy 6,650 feddan, namely, about 14 percent of dry land area.

Many light yellowish brown transparent gypsum flakes (2 - 20 mm long) on the surface and/or many fine white crystals in the profile are characteristic feature of these soils. According to the chemical analysis, these soils contain around five percent of gypsum.

These soils contain little organic matter. There is almost no natural vegetation on these soils.

Note: 1/ For mapping, the soils belonging to the fine clayey, montmorillonitic, thermic family were further divided by the depth of reduced layer.

These soils have constraint of drainage for irrigated agriculture.

In the Project Area, a very-fine clayey, montmorillonitic, thermic family of Typic Gypsiorthids was found.

c. Typic Torriothents

On clay dunes, no significant salic horizon nor any diagnostic horizons could be identified, therefore, the soils were classified as Typic Torriorthents. These soils are found on gentle or moderate slopes and have a limited acreage of 1,600 feddan, that is, about three percent of dry land area.

The low dunes and hummocky lands consist of aeolian deposits derived from the fluffy soil surface of the surrounding clay flats. Because of relatively deep groundwater table, the salts have not accumulated in the surface layer. As the result, the soils do not have a salic horizon and the salinity is less than surrounding lands of other soils. These soils have little organic matter because of sparse natural vegetation. Only zerophytic shrubs of Tamarix Nilotica Ehreab are found. These shrubs contribute to form hummocky land surface. These lands are highly susceptible to erosion.

A fine loamy, montmorillonitic, thermic family is found in the Project Area.

3.3.2. Swamps and Inundated Area

The swamp and inundated lands, which have an acreage of 27,560 feddan, about 37 percent of total Project Area, cover the northern half of the Project Area. These lands adjoin the North Hussinia Project Area with the El Salam Canal.

The lands are permanently submerged by brackish water the salt content of which ranges from 9,600 to 37,400 ppm. The profiles showed only gleization but no other diagnostic horizons. The profiles consist of mainly montmorillonite clay having a very shicky consistency, and have a compacted substrata. In the profiles near the north east corner of the Project Area (about 1,730 feddan), sandy loam or sandy clay loam layers were observed.

Because the clay has deposited under the water, the bulk density is small and the moisture content is high. On the top layer, very soft clay has deposited followed by a considerably hard layer having n-value of more than one.

For mapping, these lands were tentatively classified into the Sulfic Hydraquents because these profiles did not show any pedogenic diagnostic horizons except for the gleization, and the layer rich in sulfidic materials. Although there is a conflict about the adaptability of the Soil Taxonomy System for the permanently submerged lands, they were further subdivided into two families below;

- Very-fine clayey, montmorilloritic, thermic, and
- Very-fine clayey over loamy, montmorillonitic, thermic

Salicornia Chenopodium and Phragmite are predominant natural vegetation. Fish ponds have been constructed at the fringe of the inundated area.

Because the water content is high, the soil strength is low, commonly too low to support grazing animals unless strengthening by natural vegetation.

Furthermore, according to the survey made for the North Hussinia Project, it was revealed that these sediments were rich in sulfidic materials.

When the swamps and inundated lands are desiccated, the bulk density increases and the montmorillonitic clay makes cracks. And the sulfidic materials are oxidized and show the sulphate-acid.

3.4. Drainage, Salinity, and Alkalinity

3.4.1. Drainage Problem

The Project Area is predominantly situated on clay flats formed of fluvio-marine deposits.

The following factors restrict the drainability of soil.

(1) Montmorillonitic clay,
(2) Undeveloped soil structure,
(3) Shallow groundwater table,
(4) Poorly permeable compacted layer in subsoil,
(5) High exchangeable sodium content.

Such a poor drainability has resulted in waterlogging here and there in the Project Area.

The drainability was determined from the results in-place hydraulic conductivity measurement, soil profile morphology and soil physical tests as well as taking into consideration groundwater status and topographical conditions.

For the land drainability classification, the specification was made as follows;

Drainability Class	Hydraulic Conductivity Possible Rate in m/24 hrs	Soil Texture
1. Moderately well	> 0.5	SiL, SL
2. Moderate	0.25 - 0.5	SiCL, SCL, SiL
3. Moderately poor	0.1 - 0.25	SiCL, SiC
4. Poor	0.05 - 0.1	SiC, C
5. Very poor	< 0.05	C, HC

Figure III-5 shows a drainability classification map, and the acreage of each drainability class is shown below;

Drainability Class	Area (feddan)	Area (%)
1. Moderately well	5,300	7.1
2. Moderate	8,210	11.0
3. Moderately poor	9,560	12.8
4. Poor	16,730	22.4
5. Very poor	34,900	46.7
Total	74,700	100.0

About a half of the Project Area has very poor drainability under the prevailing conditions, therefore, the improvement of soil drainability is the most important for the reclamation of these lands, followed by leaching.

3.4.2. Soil Salinity

The soil salinity was estimated by measuring the electrical conductivity of saturation extract of the soil. Figure III-6 shows the correlation between ECe and total soluble salts (TSS).

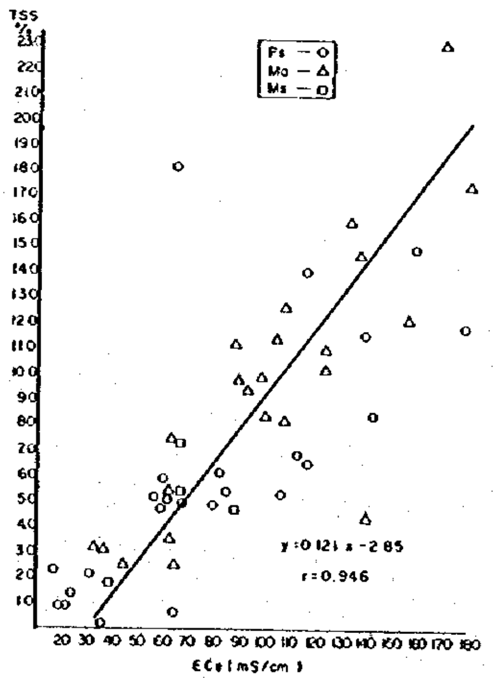
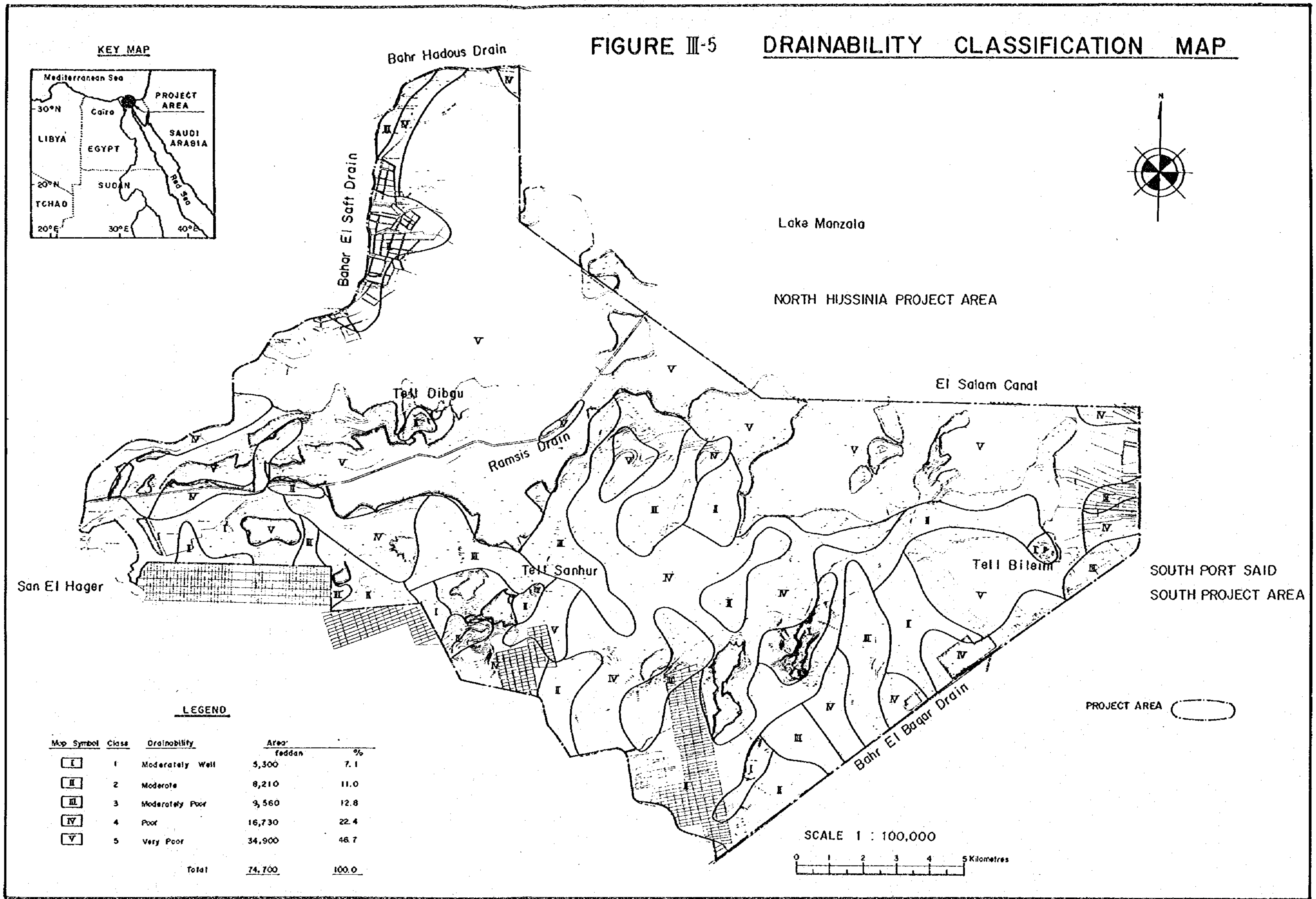


Figure III-6 Relation between ECe and TSS



Map Symbol	Class	Drainability	Area feddan	%
I	1	Moderately Well	5,300	7.1
II	2	Moderate	8,210	11.0
III	3	Moderately Poor	9,560	12.8
IV	4	Poor	16,730	22.4
V	5	Very Poor	34,900	46.7
		Total	74,700	100.0

FIGURE III-5 DRAINABILITY CLASSIFICATION MAP

There is a highly positive correlation between ECe and TSS.

As shown in the results of chemical analysis, the Project Area soils are characterized by their high salinity, namely, the ECe values of most soils exceed 16 mS/cm.

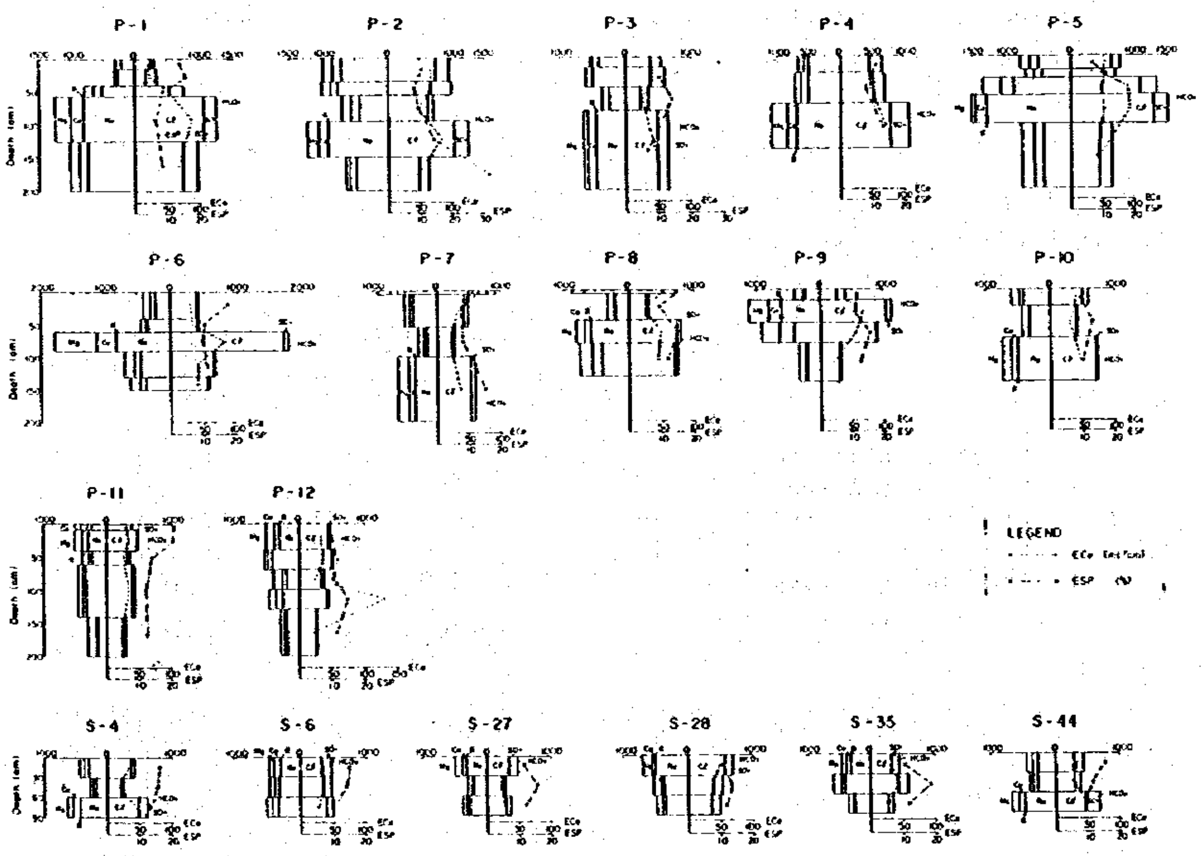
According to the difinition made by the US Salinity Laboratory, the most Project Area soils belong to the category of saline soils.

US Salinity Laboratory's Definition

	ECe (mS/cm)	ESP (%)	pH
Saline Soils	> 4	< 15	< 8.5
Alkali Soils	< 4	> 15	> 8.5
Saline-Alkali Soils	> 4	> 15	> 8.5

Figure III-7 shows the vertical distribution of cations and anions, as well as ECe and ESP. As shown in this figure, sodium and

Figure III-7 Cation-Anion Distribution, ECe, and ESP of Soil Profiles



chloride are the predominant cation and anion, respectively. The vertical salts distribution shows a tendency of relatively uniform distribution with depth in the cultivated lands (P-3, P-11, P-12). On the other hand, salts have been accumulated at a certain depth in the non-cultivated lands.

The salts in the surface soil have been accumulated by the capillary upward movement. The sdalt regime index proposed by Polynov (1956) was calculated by the following formula;

$$S = \frac{\text{Groundwater } Cl/SO_4}{\text{Surface Soil } Cl/SO_4}$$

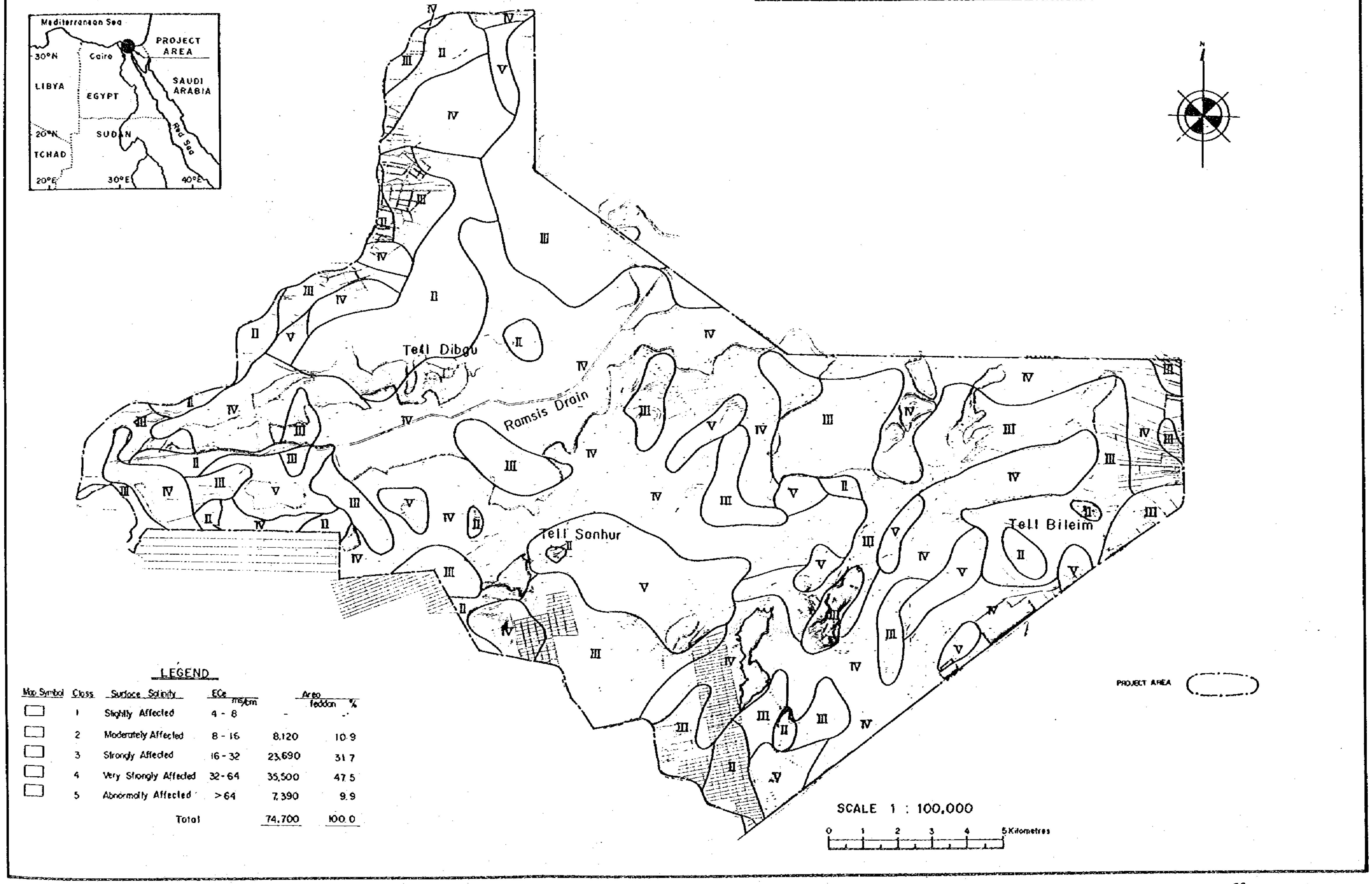
When the index (S) is less than one, it points out that the upward capillary movement of soil solution is continuous and the process of salinization takes place.

Applying this formula for the Project Area, most of Project Area soils are still under the salinization process with a few exceptions of some portions in the presently cultivated lands having coarser texture than clay flats.

The salinity classification of surface soils and subsoils were made as shown in figures III-8 and III-9, and the acreage of each salinity class was summarized below;

Class		EC	Surface Salinity Area		Subsoil Salinity Area	
		(mS/cm)	feddan	%	feddan	%
1.	Slightly Affected	4 - 8	-	-	1,290	1.7
2.	Moderately Affected	8 - 16	8,120	10.9	5,200	7.0
3.	Strongly Affected	16 - 32	23,690	31.7	37,580	50.3
4.	Very Strongly Affected	32 - 64	35,500	47.5	25,530	34.2
5.	Abnormally Affected	64	7,390	9.9	5,100	6.8
	Total		74,700	100.0	74,700	100.0

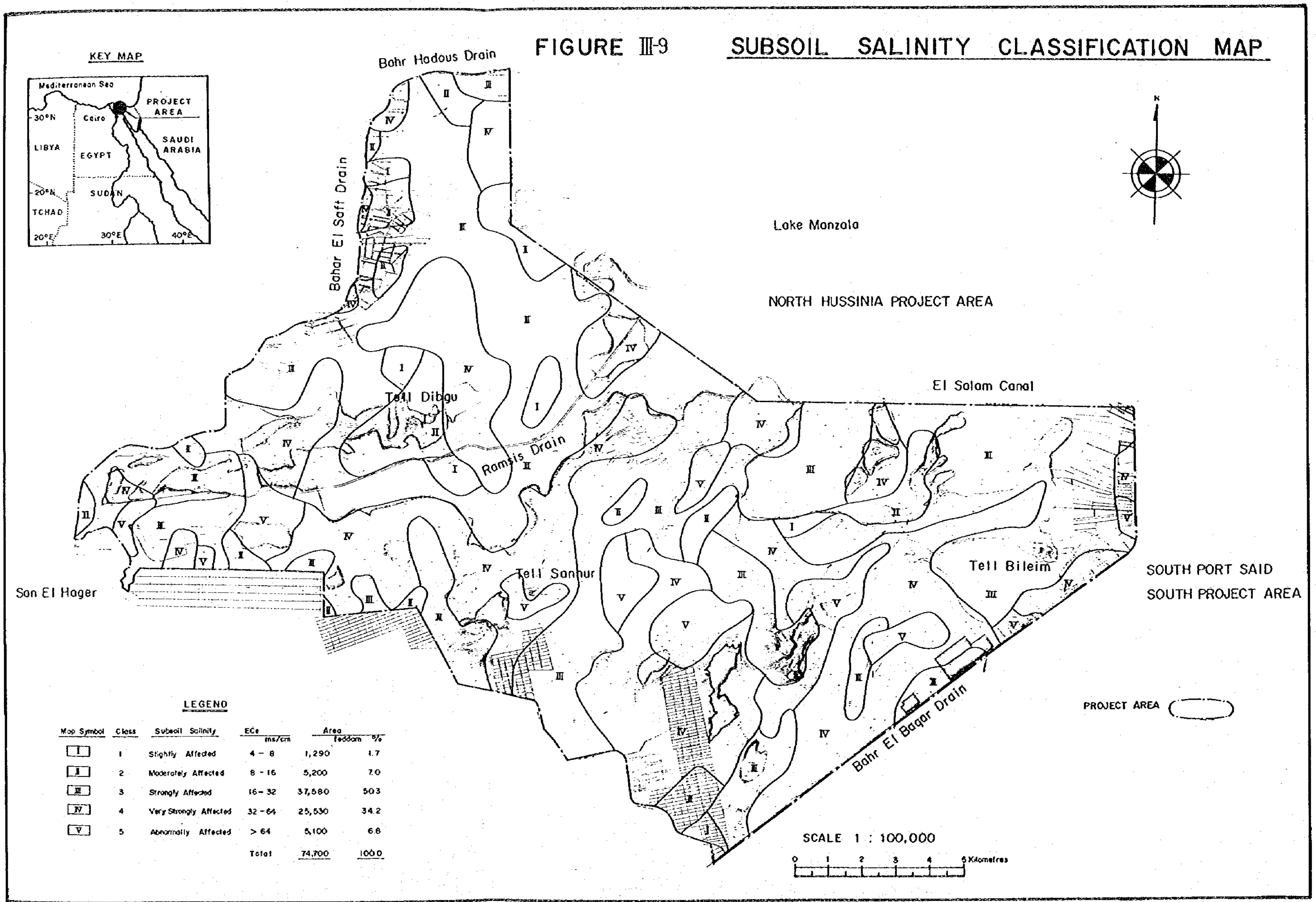
FIGURE III-8 SURFACE SALINITY CLASSIFICATION MAP



LEGEND

Map Symbol	Class	Surface Salinity	ECe mS/cm	Area feddan	%
☐	1	Slightly Affected	4 - 8	-	-
☐	2	Moderately Affected	8 - 16	8,120	10.9
☐	3	Strongly Affected	16 - 32	23,690	31.7
☐	4	Very Strongly Affected	32 - 64	35,500	47.5
☐	5	Abnormally Affected	>64	7,390	9.9
		Total		74,700	100.0

FIGURE III-9 SUBSOIL SALINITY CLASSIFICATION MAP



LEGEND

Map Symbol	Class	Subsoil Salinity	ECe ms/cm	Area feddan	Area %
I	1	Slightly Affected	4 – 8	1,290	1.7
II	2	Moderately Affected	8 - 16	5,200	7.0
III	3	Strongly Affected	16 – 32	37,580	50.3
IV	4	Very Strongly Affected	32 – 64	25,530	34.2
V	5	Abnormally Affected	> 64	5,100	6.8
			Total	74,700	100.0

For both surface and subsoils, about 90 percent of total area shows a strong salt accumulation; more than 16 mS/cm in both surface and subsoils.

Figure III-10 shows the depth of groundwater table and groundwater salinity. Most of groundwater have extremely high salinity, except for some shallow groundwater having connection with stagnant water in inundation area.

3.4.3. Soil Alkalinity

Soil alkalinity causes a severe soil permeability problems as well as toxicity problem of sodium. High exchangeable sodium induce the dispersion of clay fractions, and as a result, the soil structure is degraded and the soil permeability reduced considerably.

Some parts of the Project Area fall into the category of saline-alkali soils according to the US Salinity Laboratory's classification, namely, the ESP values exceed 15. Roughly speaking, these saline-alkali soils extend in the cultivated areas where the lands have been irrigated.

3.5. Land Reclaimability Classification

In the Phase I Report, the land classification for land reclamation was made based on the soil potentiality evaluation. In the present study, however, the reclaimability of lands in the entire Project Area was classified in accordance with the USBR system.

The specifications of land reclaimability classification was prepared, following the principle of the USBR system. Following Table shows the specifications for the Project Area.

Specifications of Land Reclaimability Classification

Land Characteristics	Class 1 - Arable	Class 2 - Arable	Class 3 - Arable	Class 4 Limited Arable
Soil				
Texture	SiL, SCL, SiCL	SiL, SCL, SiCL	SCL, C	C
Depth to hard pan or to barrier layer	> 2.00 m	> 2.00 m	> 1.50 m	> 1.00 m
Salinity (ECe)	< 4 mS/cm	< 8 mS/cm	< 16 mS/cm	< 32 mS/cm
Alkalinity (ESP)	< 15%	< 15 %	< 15%	< 15%
" (pH)	< 8.0	< 8.0	< 8.5	< 8.5
Topography				
Slope } Relief	No restriction	No restriction	No restriction	Slightly rough surface
Drainage				
Hydraulic conductivity	Moderately well	Moderate	Moderately poor	Poor
Groundwater table	> 200 cm	> 150 cm	> 100 cm	> 50 cm

Note: Class 5: Include lands which are continuously submerged by water.

Class 6: Include lands which do not meet the minimum requirements for the other land classes.

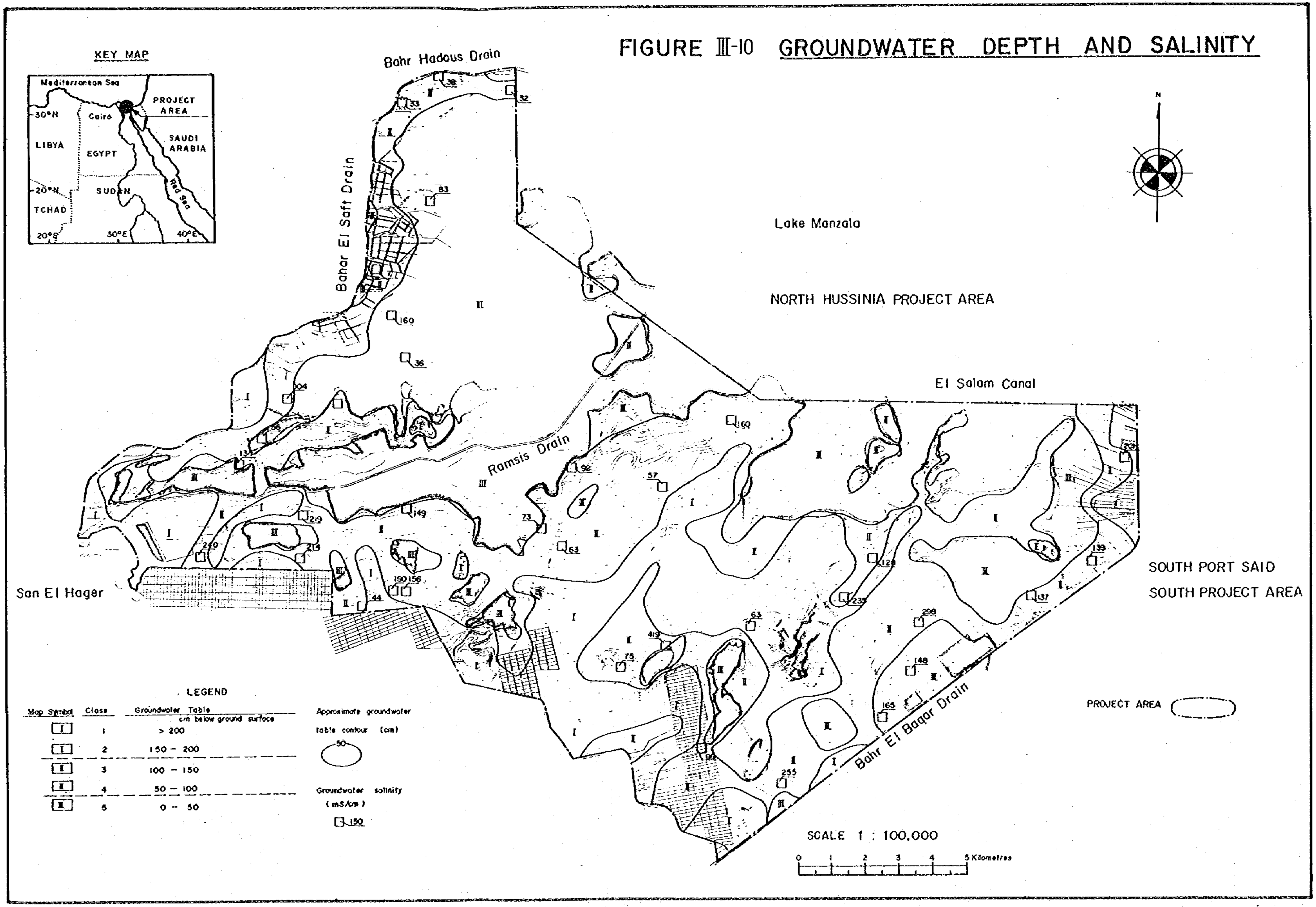


FIGURE III-10 GROUNDWATER DEPTH AND SALINITY

This system classifies the irrigation suitability of lands into six classes according to the physical aspects of land, that is, soil topography and drainage conditions.

The each class is as below;

Class 1: Lands that are highly suitable for irrigation agriculture.

Class 2: Lands that are moderately suitable for irrigation agriculture

Class 3: Lands that are marginally suitable for irrigation agriculture

Class 4: Lands that are limitedly arable

Class 5: Lands that are non-arable under existing conditions. After the desiccation, these lands will be divided into either arable or non-arable lands

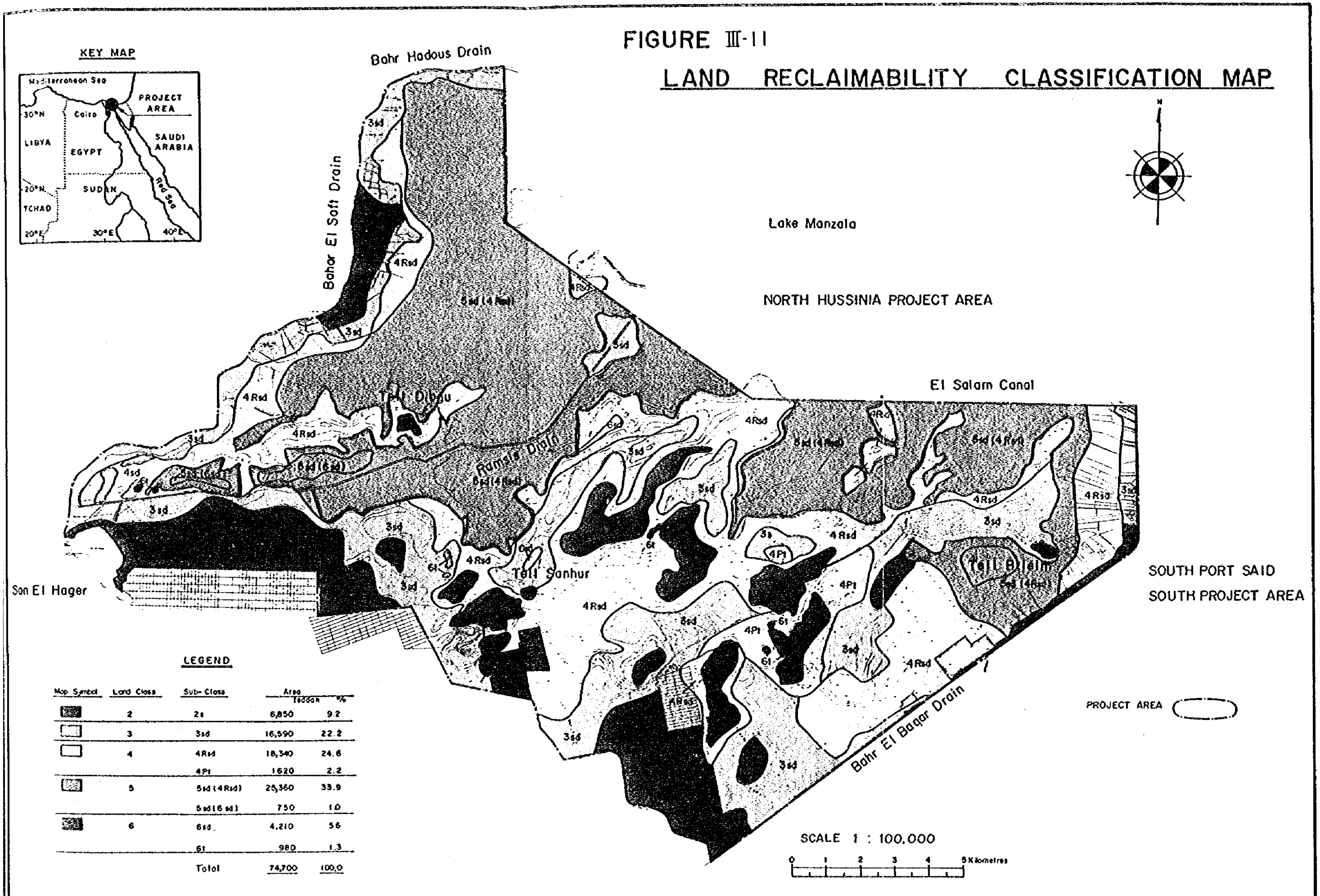
class 6: Lands that are non-arable

The land classes except for Class 1 are further sub-divided into eight subclasses by the limiting factors, 2s, 3sd, 4Rsd, 4Pt, 5sd (4Rsd), 5sd(6sd), 6t and 6sd.

As the results of field investigation and laboratory analysis, a land relcaimability classification map of the Project Area was prepared as shown in Figure III-11, and the acreages by land reclaimability classes are as below;

FIGURE III-11

LAND RECLAIMABILITY CLASSIFICATION MAP



LEGEND

Map Symbol	Land Class	Sub-Class	Area Feddan	%
	2	2s	6,850	9.2
	3	3sd	16,590	22.2
	4	4Rsd	18,340	24.6
		4Pt	1620	2.2
	5	5sd (4Rsd)	25,360	33.9
		5sd (6sd)	750	1.0
	6	6sd	4,210	5.6
		6t	980	1.3
		Total	74,700	100.0

Land Class	Sub Class		Area feddan	%
Class 2	2s		6,850	9.2
Class 3	3sd		16,590	22.2
Class 4	4Rsd		18,340	24.6
	4Pt		1,620	2.2
		Sub-total	19,960	26.8
Class 5	5sd(4Rsd)		25,360	33.9
	5sd (6sd)		750	1.0
		Sub-total	26,110	34.9
Class 6	6sd		4,210	5.6
	6t		980	1.3
		Sub-total	5,190	6.9
	Total		74,700	100.0

As shown in the classification map, there are no Class 1 lands to be found within the Project Area. General descriptions for each subclass are as follows;

Class 2s: The lands are best suited to the irrigated agriculture within the Project Area. Large portion of these lands are presently cultivated or have been levelled for cultivation. These lands have no limitations for reclamation except for salinity. The salinity is correctable. Because the drainability is moderately well or moderate, leaching can be readily carried out. Various field crops can be grown on these lands. These lands are distributed along the western and southern boundaries of the Project Area.

Class 3sd: The lands are suitable for irrigated agriculture, but greater risk may be involved in farming them than the better classes of lands. Under proper management they are expected to have adequate payment capacity. Most lands of this class have inferior drainability to the Class 2 lands, therefore, leaching may be more intensive, that is, dense spacing of drains, and soil improvement may take a longer time. Some salt tolerant plants such as Salicornia and Tamarix are beings grown. Some parts of these lands are now used as rice paddy. Field crops as well as paddy rice can be grown on these lands after leaching.

Class 4Rsd: These lands have drainage and salinity limitations for reclamation. In particular, drainability of these lands is inferior to the better classes. Most lands of this class are barren or are used as fish pond at present. Sufficient leaching through providing a dense drain network is required. After leaching, these lands can be used as paddy field. Furthermore, some field crops may be cultivated under proper management.

Class 4Pt: These lands have unfavorable relief, such as clay dunes. The topogrpahy limitation can be ameliorated so these lands should be included in the reclaimable area. The drainability is fair, therefore, salinity may be corrected with ease. The surface of the land is covered with win-blown puffy silty clay. Small shrubs, mainly Tamarix grow sparsely on these lands. These lands can be used as pasture, however, some field crops may be cultivated under proper management. These lands are distributed in the foothill areas.

Class 5sd: Swamp and inundated lands which are continuously submerged by water fall into this class. First of all desiccation of lands is necessary for reclamation. Most lands in this class may be arable, however, drainability is very poor so that further detailed investigation is required after desiccation before final evaluation can be made. Tentatively, these lands are anticipated to be Class 4Rsd after desiccation, 5sd (4Rsd). In small portions, the land surface may form depressions after desiccation, therefore, those parts may be excluded from the reclaimable area, 5sd (6sd).

Class 6t: These lands are elevated and segregated from the surrounding area. These hills are locally called "Tell" and most of them are ruins of ancient dwellings. The lands have fair drainage condition, however, irrigability is poor because of their higher elevation. These lands are barren at present. The higher lands are situated on the southern fringe of the Project Area, however, they have continuous elevation to the surrounding area. Therefore, their topography may not be a constraint for irrigated agriculture using the gravity system.

Class 6sd: The lands are mostly depressions or swamps. Some of them are permanently submerged by brackish water flowing into adjoining lands. The soils have very poor drainability in general. Even though the soils have fair permeability, discarding the drained water is difficult. Finally, these lands are excluded from the reclaimable area because of their strong salinity as well as very poor hydraulic conductivity. Leaching may be tedious due to the restricted drainage. At present, most lands are barren.