JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF PUBLIC WORKS AND WATER RESOURCES
ARAB REPUBLIC OF EGYPT

THE FEASIBILITY STUDY ON THE NORTH SINAI INTEGRATED RURAL DEVELOPMENT PROJECT (PHASE II) IN THE ARAB REPUBLIC OF EGYPT

FINAL REPORT

MAIN REPORT

MARCH 1997

SANYU CONSULTANTS INC.
PACIFIC CONSULTANTS INTERNATIONAL

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF PUBLIC WORKS AND WATER RESOURCES
ARAB REPUBLIC OF EGYPT

THE FEASIBILITY STUDY
ON
THE NORTH SINAI INTEGRATED RURAL DEVELOPMENT PROJECT (PHASE II)
IN
THE ARAB REPUBLIC OF EGYPT

FINAL REPORT

MAIN REPORT

MARCH, 1997

SANYU CONSULTANTS INC.
PACIFIC CONSULTANTS INTERNATIONAL

PREFACE

In response to the request from the Government of Arab Republic of Egypt, the Government of Japan decided to conduct a feasibility study on the North Sinai Integrated Rural Development Project (II) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Arab Republic of Egypt a study team headed by Mr. Kunio Ota, Sanyu Consultants Inc., and composed of staff members of Sanyu Consultants Inc. and Pacific Consultants International, three times between March, 1996 and January, 1997.

The team held discussions with the officials concerned of the Government of Arab Republic of Egypt, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and the enhancement of friendly relations between our two countries.

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

Kimio Fujita
President
Japan International Cooperation Agency

March, 1997

March, 1997

Mr. Kimio Fujita
President
Japan International Cooperation Agency (JICA)
Tokyo, Japan

Dear Sir,

Letter of Transmittal

We are pleased to submit to you the feasibility report on the North Sinai Integrated Rural Development Project (Phase II) in Arab Republic of Egypt. The report, during the course of the above-mentioned project formulation, has been given due consideration to the advice and suggestions of the authorities concerned of the Government of Japan and your Agency, and to the comments made by the North Sinai Development Organization in the Ministry of Public Works and Water Resources of the Government of Arab Republic of Egypt during technical discussions on the draft final report which were held in Egypt.

This project is designed to reclaim desert land of 135,000 feddans for agricultural development, with the broad objectives of achieving better food security and contributing more to the economic development of the country. The project will be implemented in an integrated manner so as to establish new rural communities, entailing the implementation of irrigation and drainage development, agricultural extension services, agro-processing industries and settlement programmes.

Irrigation is indispensable for sustainable agricultural development in Egypt for its arid climate. The construction work of Suez siphon to cross the Suez Canal is scheduled to be completed in 1997, by which fresh Nile water is to be available for agricultural use in Sinai peninsula. Under the situation, the proposed integrated rural development project should be implemented as closely as possible to the proposed implementation schedule.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan. We also wish to express our deep gratitude to the North Sinai Development Organization in the Ministry of Public Works and Water Resources of the Government of Arab Republic of Egypt for the close cooperation and assistance extended to us during our studies.

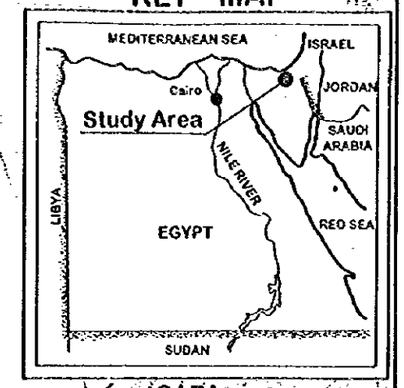
Very truly yours,

Kunio Ota
Leader of the Study Team

THE NORTH SINAI INTEGRATED RURAL DEVELOPMENT PROJECT (PHASE II)

LOCATION MAP

Scale 1:1,000,000



MEDITERRANEAN SEA

GAZA

ISRAEL

DAMIETTA

PORT SAID

PORT FOUAD

EL SALAM CANAL

EL SALAM CANAL SIPHON

NILE RIVER (Damietta Branch)

SERW DRAIN

MANSURA

BAHR HADOUS DRAIN

BAHR EL-BAKAR DRAIN

EL-KANTARA

BARDAWIL LAKE

EL-ARISH

SHIKH GABER EL SABAH CANAL

ZAGAZIG

ISMAILIYA

SUEZ CANAL

WADI EL-ARISH

CAIRO

NILE RIVER

SUEZ

GULF OF SUEZ

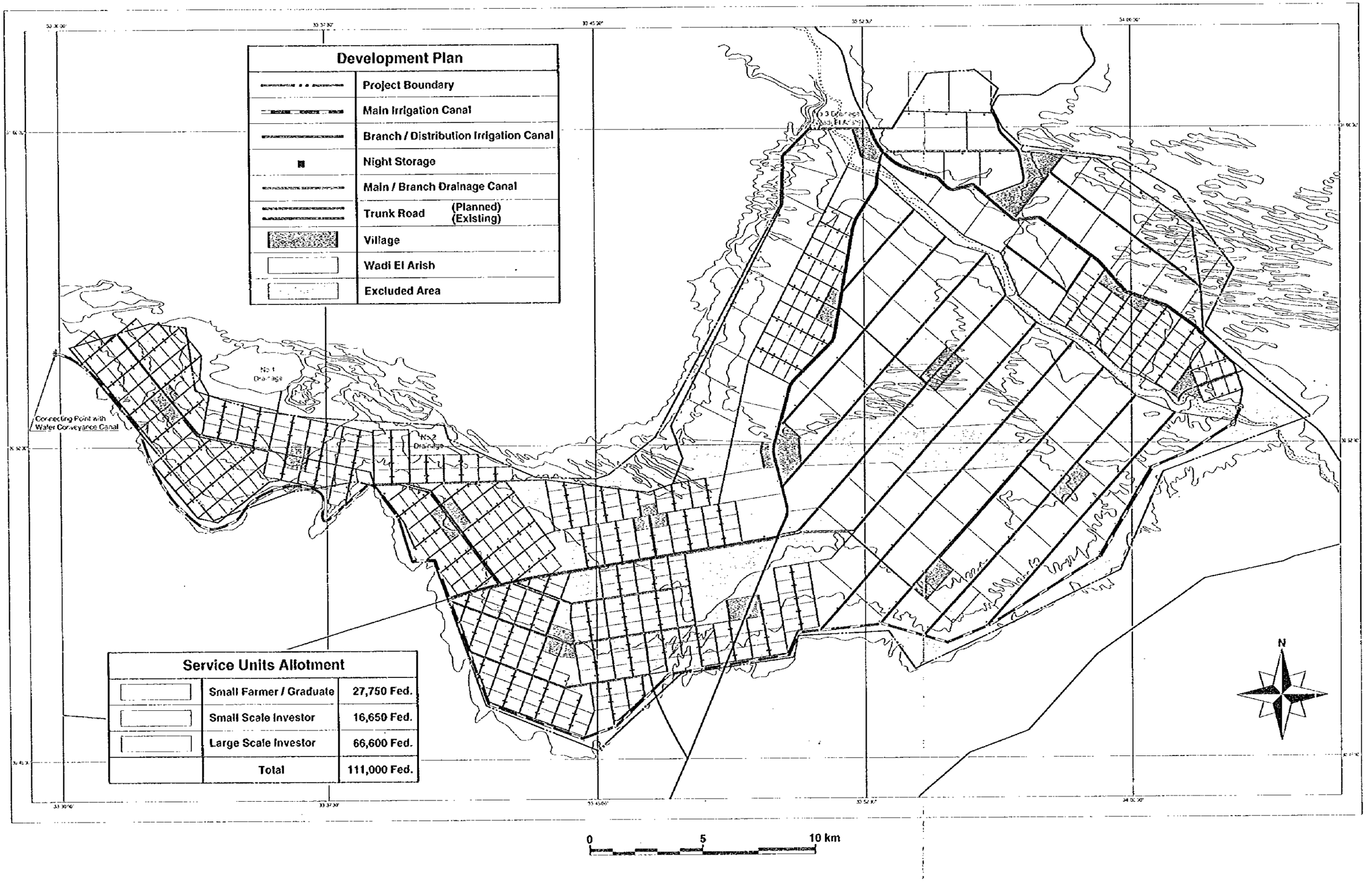
1	EL Attawi & EL Mature Zone	13,000 Fed.
2	North EL Heseneya Plain Zone	30,000 Fed.
3	South EL Heseneya Plain Zone	64,000 Fed.
4	South Port Said Plain & East Bahr EL Bakar Zone	47,000 Fed.
5	South Port Said Plain Zone	45,000 Fed.
6	Berket Om EL Reesh Zone	21,000 Fed.
	Total	220,000 Fed.

7	Tina Plain Zone	50,000 Fed.
8	South Eastern Kantara Zone	75,000 Fed.
9	Rabaa Zone	70,000 Fed.
10	Bir EL Abd Zone	70,000 Fed.
11	EL Sir & EL Kawareer Zone (Study Area)	135,000 Fed.
	Total	400,000 Fed.

LEGEND	
	International Boundary
	City / Town
	Primary Roads
	El Salam Canal Shikh Gaber El Sabah Canal
	Drainage

THE FEASIBILITY STUDY ON THE NORTH SINAI INTEGRATED RURAL DEVELOPMENT PROJECT (PHASE II) IN THE ARAB REPUBLIC OF EGYPT

GENERAL PLAN



Summary and Recommendations

SUMMARY AND RECOMMENDATIONS

SUMMARY

1. INTRODUCTION

(Background of the Study)

In accordance with the Scope of Works agreed upon between the Ministry of Public Works and Water Resources (hereinafter referred to as "MPWWR"), the Government of Arab Republic of Egypt (hereinafter referred to as "Government of Egypt"), and Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, dated December 12, 1995, JICA sent the Study team organized by Sanyu Consultants Inc. and Pacific Consultants International on April, 1996 to Egypt to carry out the feasibility Study on the North Sinai Integrated Rural Development Project - Phase II (the Study).

The objective of the Study is to formulate an integrated rural development plan for newly reclaimed 135,000 feddan area in North Sinai with agricultural purposes. The Study was scheduled to be conducted in two stages through 1996 to 1997. This final reports present the result of the Study carried out in close cooperation with the North Sinai Development Organization in the MPWWR (hereinafter referred to as "NSDO").

(Agricultural Sector)

Egyptian agricultural sector's growth was boosted significantly by the completion of the High Aswan Dam in 1968. The sector contributes greatly to the socio-economic development of the country. In 1995, its share in GDP formation was close to 17 percent, exports of agro-products accounted for around 11 percent of the total merchandise exports and the portion of employment was about 32 percent.

Arable land in the country is limited to such a small extension as 7.5 million feddans, which devotes only four percent of the national territory. Being situated within arid zone, irrigation is a critical factor on farming. Egypt's limited arable land has forced the country to rely on food imports to satisfy domestic food demands.

Since the initiation of the structural reform, the Government of Egypt has embarked reform programs of the agricultural sector, which aimed at, among others, removal of crop area allotment, delivery quotas and producer prices with exception of cotton and sugarcane, elimination of subsidies for feed, fertilizers and agro-chemicals, privatization of marketing of agro-products and inputs, and liberalization of trade of most agricultural commodities.

(Land Reclamation)

With an annual population growth rate of about 2.2 percent, population living in rural areas has continuously migrated into urban area, thus leading to disproportional distribution over the country. One of the priority projects for even distribution of the population is to implement the projects for reclaiming 400 thousand feddans in North Sinai as set forth in the Third Five Year National Plan.

(Water Resources)

Water resources in Egypt are limited to the country's share of Nile water plus minor amounts of rainwater, groundwater and others. The High Aswan Dam with a total storage capacity of 160 billion cubic meters was inaugurated in 1971. Of average annual inflow to the dam of 84 billion cubic meters, 55.5 billion cubic meters are allocated to Egypt according to the Nile Waters Agreement of 1959.

Agriculture is currently using 53.3 billion cubic meters of water. It is projected by year 2000 that agricultural demands will increase to be 57.6 billion cubic meters in order to irrigate an extra 1.2 million feddans of reclaimed land. The MPWWR is making every effort to meet the water demand by increasing drainage water reuse and groundwater extraction, reuse of treated sewerage water, and improving irrigation efficiencies.

(El Salam Canal)

Construction of the El Salam canal was completed in 1990 over a distance of 87 km from the Damietta intake to the Suez Canal, and construction of the Suez Canal siphon is scheduled to be finished by the middle of 1997. The total command area of the El Salam canal is 620,000 feddans: 220,000 feddans for the western bank of the Suez Canal; 400,000 feddans for the eastern bank of the Canal.

The El Salam canal is to convey a required water of 4.45 billion cubic meters per year, of which 2.11 billion cubic meters will constitute fresh water supplied from Nile water and the remaining 2.34 billion cubic meters from two drains of Hadous and Serw. The salinity of the mixture will be of range 800 - 1,000 ppm.

2. GENERAL DESCRIPTION OF THE STUDY AREA

(Location)

The Study area is located in El Sir and El Kawareer within North Sinai governorate, 400 km north-east of Cairo. It is about 30 km from El Arish, the biggest city on Sinai Peninsula, to the center of the Study area where lies between latitude 30° 45'N and 31° 00'N, and longitude 33° 30'E and 34° 05'E.

The Study area, which is called El Sir and El Kawareer zone, has boundaries that were determined by the MPWWR and the Ministry of Agriculture and Land Reclamation (hereinafter referred to as "MALR") based on the results of soil surveys carried out in 1994. The land area is estimated at 155,500 feddans, of which 135,000 feddans of land has been selected for agricultural development.

(Soils and Lands)

Soil types prevailing in the Study area are silty/silty clay soil and sandy soil; sharing 52.3 percent and 47.7 percent respectively. Being located in Wadi El Arish valley, soils are derived from calcareous sand stone. Soil acidity varies from 7.3 to 9.4, alkaline soil. Soil fertility is very low. Soils are characterized by poor physical and chemical conditions which are not ideal for agricultural use, unless water and soil management is applied.

The lands in the Study area are broadly classified into four land forms: flat land, almost flat/gently sloping land, slightly undulating/undulating land, and hilly land which is not suitable for crop cultivation because of shallowness, high gravel content and steep slopes.

(Climate and Hydrology)

The Study area experiences arid desert climate. Annual rainfall in El Arish ranges between 31 mm and 226 mm with a mean annual rainfall of 129 mm. The rain falls in about 20 days per year only during the winter season. The summer season from June to September has negligible or almost zero rainfall. Mean monthly temperature ranges between 13℃ in January and 26℃ in July with an annual mean of 19℃. It is well known that a strong and hot wind, called Khamsin, blows during the spring season raising the temperature above 40℃.

Wadi El Arish, running along the north-eastern peripheral of the Study area, has a large catchment area of about 20,000 square kilometers which occupies about one-third of whole Sinai Peninsula. Rawafaa dam constructed in 1946 was raised further two meters in 1986 for the purpose of securing more water for irrigation and flood control. The storage capacity is increased from 1.96 million cubic meters to 5.3 million cubic meters. Since 1986, no flood damage was reported.

(Agriculture)

4,064 feddans of lands, or three percent of the lands in the Study area, are under cultivation. The farmers grow only wheat and barely depending on rainfall and/or flood water from Wadi. Some farms grow olive trees.

Main crops in North Sinai are wheat, peach, barely, almond, olive, tomato and orange in terms of cultivated area. The livestock keeping in North Sinai is largely depending on nomadic grazing due to the lack of water and pasture land. The number of livestock slaughtered in El Arish in 1994 was 1,163 heads for beef cattle, 403 heads for goats, 234 heads for buffaloes and 206 heads for sheep.

(Irrigation and Drainage)

Among the existing farm lands in the Study area, only few farms raise olive trees using drip irrigation method. Water is delivered by water tankers from El Arish. Majority of the existing farms are not provided with any means of irrigation and drainage.

There are farms along the last 15 kilometers reach near El Arish city. The farms are irrigated by using groundwater exploited from aquifers of Quaternary sedimentations. Olive is the predominant crop. The irrigation water contains salinity of more than 3,000 ppm. Drip irrigation is applied to almost all areas with exception of a few plots in which furrow irrigation is practiced for barley cultivation.

(Socio-economy)

The Study area is situated over three administrative districts: El Hasana, El Arish and El Sheikish Zouid of the North Sinai governorate. The Study area is sparsely populated with only five villages (around 370 households). Almost all the inhabitants in these villages are Bedouin people who have settled there abandoning nomadic lifestyle and their houses including minimum social provision such as electricity and water are supplied free of charge by the North Sinai governorate office.

The economic activities in North Sinai is dominated by agriculture: plantation of olive, peach, and a variety of vegetables such as cantaloupe, water melon, tomato, green pepper and others is found around the Study area. Fishing activities are flourishing in the El Bardawil lake and in the Mediterranean Sea. Animal husbandry represented by grazing camels, goats and sheep has traditionally been the main activity among Bedouin people, but with the progress of their settlement this practice has been superseded by agricultural activities.

Manufacturing is under-developed. El Arish city is endowed with beautiful shore and palm lined beaches. Tourism has been developed up to date and is expected to expand in the near future.

(Social Infrastructure)

Two national road networks connect the Study area with Cairo. Both the national roads are paved with asphalt and are in good condition. An air route is available between Cairo and El Arish. To cross the Suez Canal, five ferry ports, one tunnel and one temporal bridge are used. All ferry boats are operated free of charge for users under the control of the Suez Canal Authority.

The current electric power loads in the North Sinai governorate are 36 mega-watts. The total power generating capacity in the Governorate is reported to be about 107 mega-watts.

Potable water supplies for North Sinai depend on the Nile water. Two pipelines convey the water from El Kantara to El Arish having a capacity of 32,500 cubic meters per day. One pipeline with a capacity of 60,000 cubic meters per day is under construction to connect El Arish with West Kantara.

(Bedouin Society)

The land in North Sinai is used by various Bedouin tribes for grazing of goats and camels, and has clearly divided boundaries, marked by trees, stones or metal posts. These boundaries are known to all tribes, and grazing land is open to all tribe members within the boundaries.

The Bedouin tribes consist of a number of clans which include a family up to 5th generation. The tribal sheikhs or heads make all important decisions regarding tribal affairs. Marriage occurs within the clan tribe, and

women rarely marry outside the tribe because this would mean forfeit of grazing rights. Bedouins live in tents or temporary shelters made from date palm leaves, however some have been settling in more permanent concrete block structures.

Customary law is an unwritten law which has been developed over many years by the tribes. It is highly developed and has a complex structure, being based around the meeting of tribal and clan heads. The tribal elders are considered to be objective and of high moral integrity and wisdom. Rules exist for the use of water because of its scarce nature. These rules do not apply to access to wells by individuals. All drinking wells are open to anyone in genuine need of drinking water. However, the use of the water for animals, cultivation or domestic use needs to be approved by the owner of the well.

Under Law Number 148 all desert land is the property of the Egyptian government and approval needs to be obtained for development of this land. The law relates to land and water rights and recognizes original ownership. Presidential decrees 147 of 1993 and 103 of 1994 to Law Number 7 of 1991 state that all the land that forms part of the 400,000 feddans to be reclaimed in North Sinai is under holding of the NSDO.

3. DEVELOPMENT PROPOSAL

3-1 Objectives of Development

The socio-economic development of Egypt has been greatly dependent on the development of its agricultural sector. To achieve better food security and contribute more to the economic development of the country whose population is growing at a rate of more than two percent, the development of agriculture is particularly important. The present cultivated lands are mostly confined to the Delta. The land area is almost one million square kilometers of which only four percent is inhabited; the remaining land is desert. About 99 percent of population concentrate in the Delta. Egypt is becoming progressively more urbanized, and consequently fertile Delta land is being converted to village/urban land.

The Nile river is the main source of irrigation. Given limited water sources, the MPWWR is making every endeavor to increase the rate of growth in agriculture through the improvement of water use in the existing irrigation systems and development of water resources. The construction of the Suez Canal siphon and the extension of the EL Salam canal is urged to make the Nile water available for use in North Sinai.

Under the situation, the Government of Egypt gives high priority to reclamation and cultivation of 400,000 feddans in the northern part of Sinai with broad objectives of ensuring food security for a rapidly growing population and generation of rural employment.

In line with the policies of the national plan, this North Sinai integrated rural development project has proposed to develop the new land of 135,000 feddans for agriculture, entailing the implementation of related development plans. The development plans will be implemented in an integrated manner so as to establish new rural community in North Sinai. This development plan has also proposed to implement the settlement plan with construction of social infrastructure, and develop small-scale industries related to agriculture which will provide opportunities for the private sector to contribute to growth and employment.

3-2 Land Development

(Land Management Category)

Out of 153,900 feddans of the land area investigated, 18,900 feddans of land was excluded from the land development plan: 6,700 feddans of movable sand dunes and 12,200 feddans of land for other land uses as envisaged by the Governorate, thus resulting in a gross area of 135,000 feddans for agricultural development.

The land management categories of the selected 135,000 feddans fall within III (moderate) and IV (poor); no category of I (excellent), II (good) and V (barren). The categories of III and IV correspond to silty/silty clay

soils and sandy soils respectively. The land in category III and IV is rated as the same class, being 'moderately good arable' in the capability system for irrigated land use of the US Bureau of Land Reclamation. Therefore, it has been concluded that all the land selected for the Study is suitable for development of irrigated agriculture.

(Land Use Plan)

The land allocated for use of village development and construction of road and canal networks and others necessary for the establishment of new communities totals 17.8 percent of the total land in the Study area. This development plan will provide for 111,000 feddans of farm lands as given below:

Land Use Plan

Land Category	Area (feddan)	Percentage
Farm Land	111,000	82.2
Village Land	5,860	4.4
Irrigation and Drainage Canal	15,420	11.4
Social Utility Land	2,720	2.0
Total	135,000	100.0

3-3 Water Conveyance and Water Management

3-3-1 El Salam Canal and Shikh Gaber El Sabah Canal

(El Salam Canal)

The construction works of the El Salam canal have been completed. The maximum canal capacity is 214 m^3/sec at the confluence of Hadous drain to allow mixing of 86 m^3/sec. Three pumping stations have been built. All the canals are of the earth canal type.

(Suez Canal Siphon)

The Suez Canal siphon with a total length of 820 meter is presently under construction to allow crossing of the Suez Canal. The total capacity of the siphon is 160 m^3/sec. The construction works are scheduled to be finished by the middle of 1997.

(Shikh Gaber El Sabah Canal)

After crossing the Suez Canal, the extension of the El Salam canal is named Shikh Gaber El Sabah canal which commands 400,000 feddans of land in North Sinai. Designs of the canal systems have been completed for a total distance of 86.5 km to command 265,000 feddans of land excluding the El Sir & El Kawareer zone of 135,000 feddans, and the construction is now underway.

Earth canals are designed for the upstream reach between Suez Canal siphon and station 24.5 KM. Over a distance of 62.0 km between station 24.5 KM and station 86.5 KM, canals are lined with concrete. Original plans proposed to provide four pumping stations, namely, station No.4, No.5 and No.6 to maintain canal water levels and pumping station No.7 at station 86.5 KM to lift the water to El Sir El Kawareer zone. The design capacity at the end point of the canal is 52.66 m^3/sec.

3-3-2 General Conditions on Water Conveyance

(Hydraulic Dimensions)

The hydraulic dimensions at 86.5 KM, hereinafter referred to as Beginning Point (BP) for this Study, are as follows:

Water Level :	NWL 15.49 m MSL
	LWL 14.49 m MSL
Discharge :	52.66 m^3/sec at maximum
	29.52 m^3/sec at minimum

(Topography)

The Study area is located south-east of the BP. The distance is about 40 km between the BP and the western edge of the Study area of which ground elevations range from 90 m to 110 m. The lowest ground elevation is around 50 m at the northeastern end of the Study area.

The BP is located in sand dune area. In the area south of N 31° Lat., undulated sand dunes with a height of around 20 meter are present. These dunes presumed to be shifting, whereas in the area north of the same Latitude, sand dunes and plains alternate at an interval of around 10 km with difference in elevation of about 10 m. Sand dunes located south of the national roads are covered with vegetation; it is presumed that sand dunes are stable.

3-3-3 Alternative Study

(General)

A pumped pressure system is inevitably required for water conveyance due to the topographic condition of the area. Water is transported from the source to the Study area in open and closed conduits, depending on topography. The water conveyance system may follow the hydraulic grade line, as open canals and box culvert canals dug through the ground, or it may depart from the hydraulic grade lines, when it consists of pressure pipelines of fabricated materials.

Because open canals and box culvert canals are constructed as far as possible using a balanced cut and fill method, they are cheap to build. Open canals are troubled by drifting sand dunes. Box culvert canals will be constructed for the reaches with active sand dunes. Pipelines usually follow the profile of the ground surface quite closely. In long pipelines, frictional resistance offered by the pipe interior is the dominant element.

In the context of the above, alternative studies have been carried out in order to select the best conveyance system that is technically sound and economically feasible. This is especially importance since the system conveys a large amounts of water (52.66 m^3/sec) over a long distance of more than 40 km, thus resulting in a large investment cost. In the study of alternative, the following parameters are important: type of conduits, material of conduits, and delivery water level at the western edge of the Study area. These will determine the capacity of the pumping station(s) and the route of the canal.

(Canal Types and Materials)

Three types of canals are applicable to the water conveyance system: they are open canals, box culvert canals and pipelines. Open canals have advantages such as low unit construction cost and little water loss in canals. Open canals will be proposed in general for areas with flat to gentle slopes. Box culvert canals will be proposed in desert lands with flat to gentle slopes.

Pipelines and pumping station(s) need high unit construction costs and high operation costs, and will be proposed in areas where no other method can be applied. Due to the large discharge and high pressures ranging from 9.5 to 17.5 kg/cm^2, four kinds of pipe materials are selected for the alternative studies; they are steel pipes (SP), prestressed cylinder concrete pipes (PCCP), fiber reinforced pipes (FRP) and ductile cast iron pipes (DCIP), all of which are being fabricated in Egypt.

- SP : The maximum diameter is 3,000 mm. Wall thickness of pipe is determined so it can withstand the inside hydraulic design pressure.
- PCCP : The maximum diameter is 2,000 mm. The limit of static water pressure is 10 kg/cm^2 and design pressure is 12 kg/cm^2.
- FRP : The maximum diameter is 2,000 mm. The limit of static water pressure is 10 kg/cm^2 and design pressure is 12 kg/cm^2.
- DCIP : The maximum diameter is 2,600 mm. The limit of design pressure is 38 kg/cm^2.

(Delivery Water Level)

The proposed farm irrigation systems include sprinkler and drip irrigation methods. Water delivery to farms from the water conveyance system is by gravity flow through canal networks to be provided by the irrigation projects. Energy required for operating the mechanized facilities will be paid by the farmers.

The proposed water conveyance system delivers the water to the western edge of the Study area which has ground elevations of 90-110 m. In determining the delivery water level (DWL), two alternative levels are selected:

DWL of 110 m : at which all farms are able to receive water by gravity.
DWL of 90 m : at which 63,000 feddans of farms (or, 47% of 135,000 feddans) are commanded by gravity. Booster pumping stations are required to deliver the water to the remaining 72,000 feddans.

(Canal Route)

In due consideration of topographic conditions and the characteristics of canals, three basic canal routes were selected based on the results of analysis of topographic maps and reconnaissance field survey as given as follows:

Route A : The route is selected to minimize the length of conveyance canals. However, it requires a long pipeline section to cross sand dunes.
Route B : The route is selected to shorten the length of the pipe section envisaged in the Route A. The route runs along the national roads as close as possible to avoid the sand dune areas.
Route C : The route bifurcates from the route B at the point 16.5 KM in east-south direction to traverse the desert lands taking the shortest route.

The route C crosses the route A at the point 19.3 KM, and a combination of the route A and C is a possible alternative. In addition to the above basic routes, all routes have two sub-alternative routes nearby the Study area depending on DWL; A-1, B-1 and C-1 for DWL of 90 m, and A-2, B-2 and C-2 for DWL of 110 m, thus totaling eight alternative routes.

(Alternative Plans)

With respect to the types of canals, the following 10 alternative plans have been formulated for the eight alternative routes:

Summary of Alternative Plans

DWL (m)	Canal Route	Length of Canals (km)			
		Pipeline	Box Culvert	Open Canal	Total
90	A-1	39.6	-	2.2	41.8
90	A-1	20.3	19.3	2.2	41.8
90	B-1	16.7	7.8	21.1	45.6
90	A, C-1	10.6	19.3	13.1	43.0
90	B, C-1	10.6	7.8	26.6	45.0
110	A-2	40.5	-	-	40.5
110	A-2	21.2	19.3	-	40.5
110	B-2	18.2	7.8	18.9	44.9
110	A, C-2	12.6	19.3	8.5	40.4
110	B, C-2	12.6	7.8	22.0	42.4

Further consideration was given to the materials of pipes. Four materials are applicable. Accordingly, 40 alternatives in total have been formulated.

(Pipelines)

Given the design discharge, numbers and sizes of pipelines are determined using hydraulic and economic considerations. The controlling hydraulic factors are available heads and allowable velocities. In general the average velocities are not more than 2.0 m/sec. The following dimensions are applied to hydraulic design of pipelines:

Pipe	Diameter (mm)	No. of Pipelines	Velocities (m/sec)
SP	3,000	4	1.862
PCCP	2,000	10	1.676
FRP	2,500	6	1.788
DCIP	2,600	6	1.653

(Main Pumping Station)

The estimated internal pressures are about 14 to 17.5 kg/cm^2 including the water hammer pressure of about 4.5 kg/cm^2. SP and DCIP can withstand the high internal pressure of a single pumping station (station No.7); however, PCCP and FRP need two pumping stations (station NO.7 and No.8) to reduce the internal pressure. Station No.8 will be located at the middle reach of the pipelines with a ground elevation of around 50 m.

Pumping units are chosen in accordance with the total heads and pump characteristics. Two types of pumps are applicable to the proposed pumping stations. They are a vertical shaft single suction diffuser and volute type and a horizontal shaft double suction volute type. The vertical type pump is proposed because of its better performance and safety in case of submergence of the pump units. Eight units of vertical pumps with a nominal bore diameter of 2,000 mm will be installed at pumping station No.7 and No.8, including one standby pump unit.

(Booster Pumping Stations)

In case of the delivery water level of 90 m, three booster pumping stations will be provided to command the areas of 72,000 feddans: No.1, No.2-1 and No.2-2. Pump units of No.2-1 and No.2-2 are installed in one building. Outlines of the booster pumping stations are as follows:

Outlines of Pumping Stations

Particulars	Unit	No.1 Station	No.2 Station	
			No.2-1	No.2-2
Command Area	feddan	4,300	33,900	33,800
Design Discharge	m^3/s	1.68	13.22	13.19
Pipelines (SP)				
- Length	km	1.0	1.4	0.6
- Diameter	mm	1,200	2,000	2,000
- Nos. of Pipelines		1	3	3
Pump: Vertical Type				
- Nos. of Pump Units	unit	2 + 1	4 + 1	4 + 1
- Total Head	m	29.5	29.2	18.6
Motor Output	KW	643	4,779	3,035

(Electric Transmission Lines)

The electric transmission line will run along the proposed water conveyance canals, starting from the national road to the respective stations. The main electric transmission trunk line (220 KV) is being constructed along the national road under the national network program. Electric requirements of the alternatives are given below:

Electric Requirements (MVA)

DWL (m)	Pipeline	Main Station		Booster Station	
		No.7	No.8	No.1	No.2
90	SP, DCIP	80	-	1	1
90	PCCP, FRP	40	45	1	1
110	SP, DCIP	100	-	-	-
110	PCCP, FRP	40	65	-	-

(Cost Estimate)

The construction costs include main pumping station(s), booster pumping stations and electric works. The costs required for construction of regulating reservoirs and irrigation networks are not included for the sake of comparison, as such costs are common to all alternatives. The preliminarily estimated construction costs fluctuate between 1,332.8 million LE for alternative 37 and 5,440.1 million LE for alternative 4. The top five alternatives with low construction costs are summarized as follows:

Construction Costs (Million LE)

Alternatives					Pumping Station	
No.	Route	DWL (m)	Cost	Pipe	Main	Booster
37	B, C-2	110	1,333	SP	No.7	-
17	B, C-1	90	1,449	SP	No.7	No.1, No.2
33	A, C-1	90	1,543	SP	No.7	No.1, No.2
38	B, C-2	110	1,556	PCCP	No.7, No.8	-
39	B, C-2	110	1,572	FRP	No.7, N0.8	-

The preliminarily estimated operation and maintenance (O&M) costs include power costs to operate pump units, operation costs of engineering facilities and maintenance costs of the system. Annual O&M costs range from 53.3 million LE (alternative 17, DWL of 90 m) to 74.0 million LE (alternative 22, DWL of 110 m).

(Economic Comparison of Alternatives)

The sum of the present value of a series of future costs for construction and O&M of the alternative water conveyance system has been computed to compare the economic preference among the alternatives.

The present value of costs are determined by multiplying the future costs by an annual interest rate of 12 percent on conditions that the project life is 50 years, the useful life is 25 years for pump equipment and 50 years for canal systems and civil works, and the system will take four years to complete.

The alternative with the lowest present value of cost is No.37, being followed by No.17. Both the alternatives take the route B to C using steel pipelines. The difference is the delivery water level: 110 m for the alternative No.37 and 90 m for No.17. In case of the 90 m alternative, booster pumping stations need to be built in the Study area.

A case study was added to evaluation of economic advantage of the alternative 37. The case study is based on the route B to C-2 and a delivery water level of 100 m at which 99,260 feddans of lands are commanded by gravity flow. Booster pumping stations supply water for 35,740 feddans.

The present value of costs is low in order of alternative 37 with DWL of 110 m, the case study with DWL of 100 m and alternative 17 with DWL of 90 m. As DWL is lowered, total power costs decrease (the DWL 90 m case is the lowest.), on the contrary, construction costs increase (the DWL 90 m case is the highest), and as a result of comparison of the present value, the DWL 110 m case has proved to be the most economic plan, and the DWL 90 m case is the highest, which may be attributed to the additional costs for construction of the booster pumping stations. The present value of costs for the additional case ranks second lowest as is given below:

Comparison of Present Value of Cost

Alternatives				Construction	Annual O&M	Present Value	
No.	Route	DWL (m)	Pipe	Cost (M LE)	Cost (M LE)	(M LE)	Ratio
37	B, C-2	110	SP	1,333	56.2	1,457	1.00
	B, C-2	100	SP	1,437	52.3	1,525	1.05
17	B, C-1	90	SP	1,449	53.3	1,541	1.06
33	A, C-2	110	SP	1,543	56.8	1,636	1.12
38	B, C-2	110	PCCP	1,556	61.5	1,683	1.16
39	B, C-2	110	FRP	1,572	59.5	1,684	1.16

As a conclusion of the economic comparison of alternatives, it has been proposed to select alternative 37 as a proposed water conveyance system, which takes the route B to C-2 with the delivery water level of 110 m.

3-3-4 Water Management

(Objectives of Water Management)

With respect to water management, the canal systems of the El Salam and the Shikh Gaber El Sabah are characterized as follows:

- The main canal systems are operated by the MPWWR. Water is distributed according to a rigid supply system, in which all parameters are fixed in advance. Farmers will arrange their cropping patterns and watering under the monthly allocation of water.
- The scale of system is large, covering the area of 620,000 feddans with long main canals of about 200 km.
- Water levels in the main canals are maintained by operation of three pumping stations for the El Salam canal system, and four pumping stations and five cross regulators for the Shikh Gaber El Sabah canal system.
- Agricultural drainage water is mixed at a predetermined rate.
- The systems have no flow measurement device, nor regulating reservoir at the pumping stations.

Under the situation, it has been proposed to establish a water management system for the El Salam canal and the Shikh Gaber El Sabah canal with the objectives of effective use of the limited water resources through minimizing waste water, maximum use of agricultural drainage water through control of its quality and quantity, and security for canal safety.

To attain the objectives, observation of water levels and water flows and establishment of a data transmission system have been proposed. The proposed data transmission will be incorporated into the current irrigation management system project under the control of the Irrigation Department of the MPWWR.

(Water Control)

Observation of water will be carried out at the following hydraulic structures and pumping stations:

Damietta Intake:	water levels, flow and quality
Serw Drain:	water quality
Serw Drain Confluence:	water quality
Pumping Station No.1 and No.2:	water flow and pump status
Pumping Station No.3:	water flow, water quality and pump status
Hadous Drain Confluence:	water quality
Baker Siphon:	water levels
Pumping Station No.4, 5, 6 and 7:	water flow and pump status
Cross Regulators at 5 locations:	water levels and gate position
Spillway at station 102 KM:	water levels

The control of water level variations in the canals is to facilitate the flow control and measurement of water at offtakes. The intake water discharge at the Damietta intake may be calibrated from water levels observed at the Nile River and downstream of the intake gates. The drainage water amount mixed into the canal may be estimated by deducting the Damietta discharge from the discharge of pumping station No 1 that is calibrated based on actual heads, pump characteristics and the number of pump units operated. Through these observations, general conditions of canal flow can be grasped as well as detection of a trouble with canal flow.

(Data Transmission)

Under the irrigation management system project initiated by the MPWWR, the main system management component was implemented. This project is known as the telemetry project. The telemetry project consists primarily of installing a country-wide telemetry system that will provide the MPWWR with real time data related to the physical status of the Nile River irrigation system. The telemetry system consists of two sub-systems: the meteor burst data collection system and the voice and data communication system (VDCS).

In conformity to the current organization system for water management, this water management system will need two supervisory stations: one is the existing Mansura El Salam canal project directorate and the other is a proposed new station to be established by the NSDO in Kantara. The former covers the El Salam canal system, while the later covers the Shikh Gaber El Sabah canal system.

The two stations will function as the sub-master station of VDCS that act as the centralized data collection point and the man-machine interface for the system operator to monitor and control irrigation operations.

The VHS radio system will be used to communicate to the 16 proposed remote terminal units: six units for the El Salam canal system and 10 for the Shikh Gaber El Sabah canal system.

3-4 Agricultural Development

3-4-1 Land Allocation

This agricultural development plan will allocate 25 percent of the entire farmland to small farmers and graduate farmers, 15 percent to small investors, and 60 percent to large investors according to the standard established by the MPWWR. Land sizes to be allocated are in principle as follows:

- For small scale investors, allocation will be made for one block or more (area ranging from 10 to 500 feddans).
- For large scale investors, allocation will be on basis of one block or more (area more than 500 feddans).

In order to prepare farming plans, it is assumed that the farm size will be 10 feddans for small and graduate farmers, 100 feddans for small investors, and 720 feddans for large investors.

Small and graduate farmers will be allocated the farm land having the highest productivity within the area classified as Class III (IIIa/IIIb) to support their farming.

3-4-2 Farming Patterns and Crop Selection

(Farming Patterns)

Small and graduate farmers will operate the complex farming of vegetables and small scale livestock keeping mainly depending on family labor. Small investors will concentrate on raising livestock or fruit farming and cultivate vegetables to supplement the raising of livestock and fruit farming. Large investors will exclusively operate land use type farming, dairy farming, fattening of beef cattle, and fruit farming. Nine farming patterns are proposed for the settlers:

Farming Patterns

Categories	Farming Patterns	No. of Households
Small Farmers	Vegetable + Livestock	1,665
Graduate Farmers	Vegetable + Livestock	555
	Vegetable + Fruit	555
Small Investors	Livestock + Vegetable	83
	Fruit + Vegetable	83
Large Investors	Land use type farming	23
	Dairy farming	23
	Livestock raising	23
	Fruit growing	23

(Crop Selection)

In addition to the soil texture, the salt tolerance of crops, the sodium absorption rate of soils and the salt concentration of irrigation water, the followings are considered in selection of crops:

- Crops having high economic return
- Crops which have already been exported
- Vegetables and oil crops for agro-industrial use
- Soliage for livestock raising

As a result of crop selection, 25 crops are proposed as given below:

Selected Crops and Yield Projection (Ton/ha)

Crops	Yield	Crops	Yield	Crops	Yield
Wheat	2.5	Broad Bean	1.2	Onion	10.8
Maize	2.7	Tomato (fresh)	40.0	Cumin	1.1
Barley	1.5	Tomato (processing)	25.0	Almond	5.0
Sorghum	18.0	Cantaloup	10.0	Peach	7.3
Berseem (long)	25.0	Water Melon	10.0	Grape	8.1
Berseem (short)	16.5	Squash	8.0	Olive	7.0
Fodder Beet	50.0	Green Pepper	7.0	Orange	7.4
Soybean	1.2	Cabbage	20.0		
Sesame	0.7	Potato	12.0		

(Cropping Patterns)

With regard to the nine farming patterns, the cropping patterns that can generate the highest possible cropping intensity have been formulated. In order to maintain these cropping patterns, farm mechanization and the increase of soil fertility with the introduction of compost and barnyard manure are necessary. The cropping patterns for small farmers and graduate farmers are summarized below:

Small Farmers of Vegetables and Livestock Farming:

- They cultivate mainly fruit vegetables such as water melons, tomatoes, and cantaloup. The seedlings are raised at the common use hot houses.
- Berseem and sorghum must be cultivated for fattening beef cattle. Barnyard manure will be composed.
- Cultivation of pulse crops such as broad beans and berseems are effective.
- In order to relieve the peak labor requirement and to avoid the plant failure, the cropping pattern must employ a four-year crop rotation system.

Graduate Farmers of Vegetables and Livestock Farming:

- The cropping patterns are almost the same as those of small farmers, but squashes are cultivated in the open-culture to reduce the labor of raising seedling and planting.
- Part of the harvested berseem will be stored in dried condition to enable a stable through-year administration of fodder.
- Manure must be composed to maintain the productivity of farm land.

Graduate Farmers of Vegetables and Fruit Farming:

- Peaches of early maturing variety will be cultivated.
- For increasing the soil fertility, it is necessary to corporate with the farmers raising livestock to secure the banyard manure.

(Land Use Intensity)

Of 135,000 feddans of lands, 111,000 feddans will be developed for crop production. The proposed cropping area is 110,500 feddans in both the summer and winter to achieve a 200 percent land use intensity, based on which irrigation water requirements are estimated. The peak irrigation water requirement of 29 m^3/day/feddan will take place in July, which is within the water right of 30 m^3/day/feddan.

3-4-3 Farm Mechanization

The farming work of small farmers and graduate farmers should be carried out mainly depending on the family labor. Because fruits and vegetables are harvested manually, seasonal workers must be employed. The farming work of investors should be carried out using large-scale mechanized systems using permanent labors.

The types and number of farm machinery are determined based on the type of crops and size of planted area. The machinery of small and graduate farmers will consist of small-scale hand tractors (8 ps) and four types of farm machinery to be attached to the hand tractors. Each small investor will be equipped with one tractor (50 ps) and 12 types of farm working machines. Large investors will use large-scale tractors (50 ps) and various other types of machineries.

3-4-4 Livestock

The number of livestock that can be raised by self-feed fodder is determined based on the nutritional value of the digestible crude protein. The required nutritional value of the digestible crude protein is 470 g/day for a head of cattle, or, 172 kg/year. With the production of fodder proposed in the cropping patterns, the small farmer and graduate farmer can raise six heads and eight heads of cattles respectively.

The beef cattle farm of small investor can raise 80 Friesian cows. Among the large investors, the dairy farmer can raise 1,372 heads of Friesian cows and the beef cattle farmer can raise 1,510 Freisian cows. Because the feeding of roughage is basically a self-choice feeding, it is necessary to supplement the insufficient nutrients with concentrated fodder.

The manure from livestock is a source with high value. The total amount of manure produced must be collected and fully utilized. This requires cooperation between the livestock raising farmers and the fruit and vegetable farmers so that it can be utilized in an organized manner. The production of these resources is estimated at 538,000 ton a year.

3-4-5 Processing of Agricultural Products

In order to increase the value added of agro-products, the processing of agricultural products must be developed in the Study area. It is proposed to establish the following agro-processing facilities to be managed by the private sector:

Concentrated Feed Factory:

21,400 ton of barely will be annually harvested in June, and 55,800 ton of maize in October. A concentrated fodder factory will be operated through the year to process 210 ton of raw materials a day.

Tomato Paste Factory:

Tomatoes for processing are harvested for 100 days starting from the end of July at the small investors farms. The total crop of tomatoes is 71,500 ton and the amount of raw materials that can be processed is 715 ton a day.

Olive Oil Extraction Factory:

Olives are harvested during 80 days starting from the end of September at a rate of 11,620 ton at 83 small investor farms and 28,900 ton at 23 large investor farms. The amount of raw materials to be processed is 508 ton per day.

Slaughter House:

A slaughter house will be built in the Study area. The processing capacity of the slaughter house is 150 heads per day.

Milk Processing Factory:

A factory having a daily processing capacity of 420 ton will be built in the Study area.

3-5 Irrigation and Drainage

3-4-1 Irrigation

The small and graduate farmers will have a service unit of 100 feddans which accommodates 10 farmers each having 10 feddans of farm plots. For the small scale investor, the typical service unit is designed to be 100 feddans. For the large scale investor, a service unit of 720 feddans, which is composed of 72×10 feddan plot (145 m×290 m), is proposed since the type is formed of generally practiced plot in almost square dimension.

Hand-move sprinklers are the best suited for the small and graduate farmers, since the system is the least complex and least cost. The small-scale investors will mostly use the fixed type sprinklers, while the large-scale investors either the fixed type or center pivot type sprinklers. Such plants as water melon, tomato, melon and onion are to be transplanted after being grown in a nursery bed. These crops will be planted at a predetermined interval, thus drip irrigation will be employed, as presently practiced in many existing project areas. Also, fruits will be exclusively irrigated by drip.

Irrigation water requirements are determined based on a conveyance efficiency of 0.90, a distribution efficiency of 0.95 (or, so-called Mesqa efficiency), and field irrigation efficiencies that vary from 0.75 for hand-move sprinkler, 0.80 for sprinkler to 0.90 for drip. The project irrigation efficiency (Ep) is given below:

Hand-move Sprinkler :	Ep = 0.90×0.95×0.75 = 0.641
Sprinkler :	Ep = 0.90×0.95×0.80 = 0.684
Drip :	Ep = 0.90×0.95×0.90 = 0.770

The irrigation water requirement is calculated on a monthly basis: the maximum irrigation water requirement is 29 m^3/feddan/day in July, and the annual irrigation water requirement is worked out to be 690 million m^3. Although leaching will be obviously required for the high salinity of the irrigation water ranging from 800 ppm to 1,000 ppm, no leaching water is added to the irrigation water requirement since the amount incurred by irrigation losses surpasses the leaching requirement.

In addition to the irrigation water requirement, the MPWWR has a plan to deliver water of 500,000 m^3/day for the purpose of future industrialization of the Study area. The water will be delivered through the proposed water conveyance system and the main irrigation canals to be provided in the Study area.

3-5-2 Drainage

Based on the recent practice in Egypt, on-farm drainage systems of buried pipes are introduced in this Study. The maximum irrigation requirement is about nine mm/day in July. Estimated seepage amounts in July and August are shown as follows:

Seepage Water in mm/day

Irrigation Method	July	August
Hand-moved Sprinkler	1.9	2.6
Automated Sprinkler	1.4	2.2
Drip Irrigation	1.1	1.9

Experimental practice in Mashtul by the Drainage Research Institute (DRI), suggests that the unit discharge at 90 percent cumulative frequency of occurrence may become less than half of the amount of peak drainage discharge. Assuming that the cumulative frequency of occurrence as defined by the DRI is 90 percent, a drainage rate of 2.0 mm/day has been proposed for the design of drainage systems.

3-6 Land Reclamation and Agricultural Infrastructure

(Land Reclamation)

Sand dunes are excluded from land reclamation projects, since grading and leveling of the vast sand dunes are not only technically difficult operation but also cause high costs imposed on land development. As a result, this plan will develop 111,000 feddans of farm land.

Even in the flat land, some areas, which consist of hard surface soil and mixed with pebbles, have problems regarding land cultivation. Large-scale earth work will be required for gravel removal and deep plowing to prepare farm lands. However, the above earth work will not be included in this plan because it will be not a remarkable problem when drip irrigation and fruit tree cultivation are done in these land.

Soil texture is sandy and is liable to be damaged by the erosion. To reduce the influence of rainfall and wind on these soil is important in conserving agricultural lands. Wind erosion not only removes soil but also damages crops, fences, buildings and roads. So, the following plans are proposed:

Shelterbelts: Trees of 50 m width will be arranged in the circumference of the Study area as wind erosion and desertification countermeasure. Prevention of vermin that tries to break into the Study area as a secondary effect.

Windbreaks: Trees will be arranged in single row in the circumference of each farm lot as wind erosion countermeasure. Trees of 5 m width will be installed in the boundary of excluded areas (sand dunes) to protect farm lands.

(Agricultural Infrastructure)

Irrigation canals will be constructed as embanking structure, in order to prevent sand accumulation breaking into the canal, and to keep the water level in higher elevation. Irrigation canals are of concrete lining of the trapezoid section. Riprap lining should be done onto the embankment to prevent slope surface collapse.

The shape of the service unit of 100 feddans is rectangular, and branch lines or tertiary canals will pass along one side of this rectangle. A night storage will be constructed in each of service unit.

The basic structure of the drainage canal will be made by digging form, and will be section of the compound trapezoid. For the top section, riprap lining will be installed with purpose of preventing slope surface collapse. Catch drains will be set up in one side of each service unit.

Main road networks will be almost completed by the roads for the operation and maintenance along with the canal networks. Standard specifications are as the following:

Trunk Road : Asphalt paving, width of 7 m
Branch Road : Simple asphalt paving, width of 4 m
Farm Road : Gravel paving or unpaving, surrounding a farm lot of 10 fed.

3-7 Settlement and Social Infrastructure

3-7-1 Land Allocation and Population Estimate

(Land Allocation)

Settlers are categorized into three groups: small farmers/graduate farmers, small-scale investors and large-scale investors. The reclaimed lands will be allocated to the settlers as follows:

Land Allocation

Category	Percentage of Land	Unit Land Area
Small/Graduate Farmers	25	10 feddans
Small-scale Investors	15	10 - 500 feddans
Large-scale Investors	60	over 500 feddans

Of the land designated for small/graduate farmers, 20 percent will be allocated to Bedouins. In this plan, average farm sizes are estimated to be: 10 feddans for small and graduate farmers, 100 feddans for small-scale investors, and 720 feddans for large-scale investors.

(Population)

The total population of the Study area with the farm land area of 111,000 feddans has been estimated at 116,100 at the full development stage of the project, assuming a family consisting of five members:

Population Estimate

Items	Farm Land (feddan)	No. of Household	Population
Small/Graduate Farmers	27,750	2,780	13,900
Small-scale Investors	16,650	170	850
Large-scale Investors	66,600	90	450
Others	-	20,180	100,900
Total	111,000	23,220	116,100

(Village Arrangement)

It is proposed to establish three central villages, each of which has four satellite villages, totaling to 15 villages. Of the five existing villages, four villages will become the centers of new villages. The proposed villages will be located at the center of the surrounding farm lands to provide easy access to the existing national roads (refer to attached figure).

(Village Plan)

The size of a village will consist of sufficient land to accommodate 20 to 30 capita per feddan. The land use of a village is arranged as follows:

Village Land Arrangement

Land Use	Percentage
Residential Area	40.0
Internal Road Network	12.5
Entertainment and Green Areas	12.5
Services, Administration and Agro-industries	25.0
Future Expansion	10.0
Total	100.0

3-7-2 Social Infrastructure

(Road Networks)

The following three types of village roads will be provided:

- Access Roads: Being the main access roads to connect a village with the national roads. Having road structures at national road level.
- Main Streets: Being main internal throughway to the central public zone of a village. Being paved with asphalt.
- Village Streets: Being the internal roads to connect residential areas with official zones. Being paved with asphalt.

(Public Utilities)

Water demand has been determined at a rate of 200 liter per capita which includes water for drinking, domestic, public, animal and small-scale industrial use. Pipeline systems will be provided to distribute the water to all houses and facilities. Hydrants will be provided along village roads.

The national electric power supply project for the development of North Sinai is to supply electricity for the villages by extending the existing service networks. Electric power demand is based on an average rate of 0.4 kW per capita including domestic, public, small-scale industrial and farming use.

Each village will be provided with one sewage treatment plant to be located outside the village. Treated water is re-used as irrigation water for windbreaks, street trees and gardens. Residual sludge is utilized as fertilizers and compost. One refuse treatment plant will be provided in a central village.

Various kinds of public service facilities for daily life will be provided in order to maintain and develop new communities.

3-8 Agricultural Development Supporting Services

3-8-1 Extension Services

(North Sinai Agricultural Development Center)

With the implementation of this land reclamation project, 2,755 families of small farmers and graduate farmers and 258 investor's farms will settle in the Study area, covering 111,000 feddans of farm land. To achieve sustainable agricultural development, it is clear that the extension and research activities need to be strengthened for the new land, placing more emphasis on small farmers and graduate farmers.

For effective implementation of extension services, it has been proposed to establish a North Sinai Agricultural Development Center (NSADC) under the control of the NSDO. NSADC will serve agricultural development for the on-going five land reclamation project areas of 400,000 feddans. The objective of the center is to transfer improved technology gained from research to farmers through the extension services.

NSADC will serve as both an administrative and training center and implement various applied examinations with respect to farming on newly reclaimed land, based on the results of which training programs to extension workers and farmers will be prepared. NSADC would be constructed in Bir El Abd. Each project will have one branch office in its project area.

One branch office will be established in the Study area as a base for extension activities for small farmers and graduate farmers. The branch office will select nine enterprising and knowledgeable farmers as farm leaders. The branch office will provide demonstration farms in the fields of the farm leaders. The demonstration farms are managed by the farm leaders themselves with close backup from extension services, and they will also provide the feedback to a large number of the other farmers.

3-8-2 Farmer Organizations

(Agricultural Cooperatives)

Agricultural cooperatives play an important role in providing services to farmers. It has been proposed to organize a multi-purpose agricultural cooperative on the basis of private initiatives. The activities of the cooperative are:

- Collection, shipment and sales of farm products
- Market research
- Procurement and sales of farm inputs and personal necessities
- Credit operation for liaison between farmers and the institutional credit services

(Farmer Association)

In the environment of liberalizing input and output prices and marketing and eliminating crop area control, farmer associations will play a significant role for promoting the agricultural development; farmers need to plan cropping patterns and select varieties of crops; they have to operate and maintain mechanized on-farm irrigation facilities at their cost; irrigation water is to be used jointly.

It has been proposed to organize farmer associations in the specific fields of vegetable cropping, fruit growing, livestock keeping and irrigation water use. The associations will function as groups which will make it easier to provide them with institutional supporting services.

3-9 Agricultural Marketing

3-9-1 Potentials on Agricultural Marketing

The following may be identified as major factors of potentials for the development of a marketing system for the project, in spite of current constraints including lack of adequate marketing infrastructure, deficient information on marketing, under-development of farmer organizations, and crossing of the Suez Canal:

Implementation of the National Project for Development of North Sinai

With the implementation of the National Projects, local demand of foodstuffs will expand drastically and the development of transport infrastructure will facilitate improvement of the transportation system of agro-products.

Geographical Advantage for Export

The project areas' geographical location will benefit the export of products to principal destinations of European and Gulf countries.

Development of Agro-industries

The National Projects propose to promote some agro-industrial development in North Sinai, and demand of raw materials for these industries will therefore grow in the near future.

Promotion of Tourism

El Arish and surrounding Mediterranean beaches are highly potential zones for development of tourism, and demand of foodstuff to hotels and other tourism-related installations will increase.

3-9-2 Agricultural Marketing System Development

The following three sub-project have been proposed to be implemented within the framework of the marketing system development plan:

Renovation of Existing Marketing Infrastructure

Presently there is one wholesale market in El Arish which is easily accessible from the Study area; however, this market is inadequate in terms of space availability and provision of necessary installation and equipment. It is therefore proposed that the existing installation of the El Arish wholesale market is innovated and expanded to meet the increase of agricultural output.

Improvement of Market Information System

Most of crops such as vegetables and fruits are actually traded in the absence of timely and reliable market information, and prices are determined in line with the force of supply and demand. An imbalance between supply and demand can occur very frequently, resulting in drastical fluctuation in price. To rectify this situation, it is strongly requested to establish a market information system both at national and regional level.

Organization of Market-oriented Cooperative

The small farmers and graduate farmers are considered to be less capable of product marketing due to deficient financial resources and less experience in marketing, which are evidenced by the field survey made during the Study period. It is recommended to organize market-oriented cooperatives.

4. THE PROPOSED PROJECT

4-1 Project Description

To accomplish the objectives of the development of El Sir & El Kawareer Zone with the total land area of 135,000 feddans, it has been proposed to implement the integrated rural development project that consists of the following main components:

(1) Water Conveyance and Water Management:

construction of water conveyance system with the capacity of 52.66 m^3/sec, including canals of 44.1 km, pumping station No.7, and water management facilities to control water flow,

(2) Land Reclamation and Irrigation and Drainage Systems:
construction of irrigation and drainage systems in the Project area by which net area of 111,000 feddans is reclaimed for agricultural development,

(3) On-farm Irrigation and Drainage Facilities:
construction of on-farm irrigation facilities that are operated by settlers themselves at the expense of them,

(4) Agricultural Development Supporting Services:
provision of supporting services to settlers with emphasis on small farmers and graduate farmers by the establishment of North Sinai Agricultural Development Center and organizations of agricultural cooperatives and farmer associations,

(5) Settlement and Social Infrastructure:
settlement of about 23,000 households with 116,100 population in 15 villages as well as provision of basic social infrastructure to develop new rural communities, and

(6) Agro-industrial Development:
provision of agro-industrial factories that will be managed by private sector, generating the value added and creating employment opportunities in rural area.

4-2 Water Conveyance and Water Management

4-2-1 Water Conveyance System

(Water Conveyance Canal)

The proposed conveyance canal departs from the station 84.9 Km from the Suez Canal, and ends at the western edge of the Project area as follows:

- Canal Types

Section	Type	Length (km)
BP - 8.7 KM	Open canal	8.7
8.7 KM - 16.5 KM	Box culvert canal	7.8
16.5 KM - 23.0 KM	Open canal	6.5
23.0 KM	Pumping station No.7	-
23.0 KM - 35.6 KM	Steel pipeline	12.6
35.6 KM - 44.1 KM	Open canal	8.5
Total		44.1

- Design Discharge : 52.66 m^3/sec
- Design Water Level : 15.62 m MSL at BP
  : 110.00 m MSL at EP
- Open Canal : concrete lining
  - bottom width : 12.00 m
  - water depth : 3.305 m
  - velocity : 0.86 m/sec
- Box Culvert Canal : reinforced concrete
  - section : 3.8 m×3,8 m×4
  - water depth : 3.30 m
  - velocity : 1.05 m/sec
- Steel Pipelines
  - diameter : 3,000 mm
  - nos. of pipelines : 4 lines
  - velocity : 1.862 m/sec
- Spillway : unlined earth canal
  - location : 102 KM
  - capacity : 52.66 m^3/sec
  - canal length : 2.0 km

(Pumping Station No.7)

Given the design discharge of 52.66 m3/sec, a suction water level of 9.9 m MSL, a discharge water level of 114.1 m MSL, and an actual head of 104.33 m, the main features of the pumping station No.7 were planned as follows:

- Pump Type : vertical shaft single suction diffuser and volute
- No. of Pump Units : 7 units and 1 standby unit, total 8 units
- Pump Discharge : 7.52 m^3/sec/unit = 451 m^3/min/unit
- Nominal Bore : 1,200 mm
- Pump Efficiency : 90%
- Motor Output : 10,400 kW (14 poles)×8 units, total 73 MW
- Total Head : 115.47 m

4-2-2 Water Management

For the control of quantity and quality of the water, the implementation of water management projects has been proposed, covering the El Salam canal system and the Shikh Gaber El Sabah canal system. The project will establish two sub-master stations, 11 zonal offices and 16 remote terminal units (RTU) with provision of necessary equipment as given below:

Sub-master Station
- Mansura office: to cover 6 projects related to El Salam canal
- Kantara office: to cover 5 projects related to Shikh Gaber El Sabah and the water conveyance system.

Zonal Offices
- West bank: 1 office for each project, total 6 offices
- East bank: 1 office for each project, total 5 offices including El Sir & El Kawareer zonal office

The remote terminal units will be established: six sites on the western bank and 10 sites on the eastern bank. Data transmission will be available by VHS radio system. Voice communication services include provision of 15 fixed stations, 19 mobile stations and 25 portable stations.

4-3 Land Reclamation and Irrigation and Drainage System

The project will provide 111,000 feddans of farm lands with the shelterbelts (green ring) which have a 50 m width and are established along the 150 km long project boundary.

The main canals run along the southern boundary of the Project area, and then cross Wadi El Arish. The siphon, formed from box culverts, is 600 m long. The drainage water will be discharged to three places; namely, Wadi El Arish and two depression areas. The design drainage discharge to Wadi El Arish is 66 million m^3 and the average throughout year is 2.09 m^3/sec. The total length of the proposed irrigation and drainage systems are 1,018 km:

Irrigation Canals	
Main canals :	71 km
Secondary/tertiary canals :	472 km
Drainage Canals :	475 km

The appurtenant structures to the irrigation and drainage systems include bridges, division works (offtakes), intakes for service units, check gates, and tail-end spillways.

4-4 On-farm Irrigation and Drainage Facilities

(Irrigation)

The system of on-farm irrigation is composed of a night storage, a boosting pumping station, media filtration facilities, distribution pipes, hydrants, control heads, and terminal devices such as sprinklers and drips. The night storage has a capacity of eight hours storage. For the boosting pump station, two duty pumps and one standby pump will be installed for a 100 feddans service unit, and four duty pumps and one standby pump for a large scale investor's service unit.

In order to remove debris, algae, sand and silt from the irrigation water, a media filter must be provided just next to the booster pumps in both cases of sprinkler and drip. The materials of pipes will be asbestos for a diameter of more than 400 mm and PVC for a diameter of less than or equal to 400 mm.

(Drainage)

In designing on-farm drainage, Class I (coarse texture) is not provided with buried drainage (pipe drainage) but open drainage. Class II (medium texture) is partly provided with buried drainage depending on topographic conditions. Class III (fine texture) will be mostly provided with buried drainage except such areas represented by relatively steep slopes with high elevations. The lateral spacing of buried drains are: 100 m for Class II and 50 m for Class III.

4-5 Settlement and Social Infrastructure

The villages proposed for this Project include three central villages with four satellite villages to each central village, totaling 15 villages.

Five types of model houses are planned. The construction works will be divided into two stages.

Settlers' House Models

Model Type	Land (m^2)	Floor Space (m^2)	Garden (m^2)	No. of Houses
Labor/Bedouin	250	96	72	16,310
Small/Graduate Farmer	350	118	112	2,780
Official Staff	400	131	128	3,870
Small Investor	400	162	128	170
Large Investor	450	206	144	90

Regarding social infrastructure, road networks, domestic water supplies of 23,200 m^3/day, electric supplies of 46,430 kW, and others necessary for establishment of rural communities have been proposed to be implemented.

4-6 Agro-processing Industries

Outlines of the proposed factories are given below:

Concentrated Feed Factory :	one factory processing capacity of 260 ton/day
Tomato Paste Factory :	one factory processing capacity of 720 ton/day
Olive Oil Extraction Factory :	31 factories processing capacity of 4 ton/day
Slaughter House :	one house processing capacity of 150 heads/day
Milk Processing Factory :	one factory processing capacity of 318 ton/day

4-7 Agricultural Development Supporting Services

North Sinai Agricultural Development Center (NSADC)
- Buildings
- Applied research farms
- Farm machineries
- Laboratory equipment
- Extension equipment
- Vehicles

Branch Office of NSADC
- Buildings
- Vehicles

Branch Offices
- Extension services office
- Veterinary services office

Farmer Organization
- Agricultural cooperatives
- Water users association
- Nine farmer associations

5. ENVIRONMENTAL ASPECT

5-1 Legal and Administrative Frame Work

The legal authority in Egypt on environmental issues is dispersed among various ministries such as the Ministry of Petroleum, the Ministry of Public Works and Water Resources, the Ministry of Health and the Ministry of Interior. The Egyptian Environmental Affairs Agency (EEAA) was set up in 1982 to coordinate the efforts of protecting the environment. In 1994, Law Number 4 was passed. It includes sections on protection of land, air and water, however, for law enforcement the EEAA still requires the collaboration of the other line ministries. Environmental Impact Assessment (EIA) are required by law for infrastructure projects such as irrigation schemes.

5-2 Environmental Site Conditions

Most of the Study area is covered with wind formed sand dunes resting on older land formations. The deposits of Wadi El Arish located in the east of the area consist of fine alluvium river sands. The wadi drains towards the Mediterranean Sea.

The flora is dominated by sparse to very sparse hummock grassland on stabilized sand dunes. The wildlife consist mainly of small mammals, none of which are endemic. The region is located on the main flyway path of many migratory birds, huge numbers of birds overwinter at Lake Bardawil. There are no endemic resident birds recorded in the North Sinai.

There are five existing settlements in the Study area with a mainly Bedouin population. Drinking water is supplied to El Arish by pipeline and from there by tanker truck to the villages, power is provided by overhead power lines and individual generators in some cases. The industry and mining sector is limited to coal mining in the Gebel El Maghara region and some light industry around El Arish.

Many archaeological sites can be found in North Sinai especially along the main road between El Arish and Kantara, but also in and around the Study area.

5-3 Discussion of Significant Environmental Impacts

Environmental impacts of the reclamation of 135,000 feddans of desert land in the El Sir and El Kawareer Zone have been subdivided into three groups as required by the EIA guidelines of the EEAA.

(Impacts due to Project Location)

The project should have a positive impact on the region with respect to creating employment opportunities, increasing income levels of the local population, improving public utilities and services. It will relieve high density population areas in the Delta Region and provide land to landless farmers.

The negative impacts due to the project location include, the possible loss of archaeological sites, the loss of land use by the existing population, and the loss of the existing natural habitat which will affect local wildlife and vegetation.

(Impacts due to Project Design)

The proposed mixing of drainage water with Damietta water for irrigation use will reduce water demand from Damietta, while modern farming practices and irrigation methods will lead to a higher productivity and better quality products. These impacts can be considered to have a positive effect.

Negative impacts related to the design include, the increase in salinity that will result from reusing drainage water. This will limit the crop selection. Reuse of drainage water could also increase the health risk for the users due to potential pollution of this water by wastewater discharges upstream. Shortages of drainage water are predicted for the months of May to June and the MPWWR is investigating additional sources such as the Faraskour drain.

(Impacts due to Project Operation)

Positive impacts of the project operation are the increase in employment in the region, and the creation of new opportunities for the development of new agriculture related industries.

Negative impacts are mostly related to the quality of the irrigation water and the use of agro-chemicals. Water with a high salinity and sodium content could potentially have a impact on the soil structure and reduce soil infiltration rates if not carefully managed. Seepage and drainage water contaminated with agro-chemicals could pollute the groundwater in the El Arish region. High nutrient loads from excessive fertilizer use could create ideal conditions for excessive growth of aquatic weeds in the canals, reducing flows and causing sedimentation.

6. IMPLEMENTATION AND OPERATION OF THE PROJECT

6.1 Implementation Program

(Executing Agency)

The North Sinai Development Organization (NSDO) of the Ministry of Public Works and Water Resources (MPWWR) will be the executing agency responsible for implementation of the Integrated Rural Development Project of the El Sir and El Kawareer Zone having the gross land area of 135,000 feddans. The proposed Project is composed of six sub-projects. For the successful implementation of the Project, the NSDO would appoint a project director who has responsibilities for promoting the Project and organizing, coordinating and directing the sub-projects.

(Implementation Schedule)

The construction works of the Suez Canal siphon is scheduled to be completed by the middle of 1997 by which the Nile water becomes available for use of irrigating 400,000 feddans of land in North Sinai. Under the situation, the MPWWR has revised the implementation schedule of the land reclamation projects in North Sinai so as to start irrigation in the year 2002.

In line with the policies set forth by the MPWWR, the implementation of basic infrastructure is scheduled to be completed during five years from 1998 to 2002, including water conveyance and water management, land reclamation and main irrigation and drainage systems, on-farm irrigation and drainage facilities, and settlement and social infrastructure. The implementation schedule is proposed to be completed in the shortest technically possible time.

As the Project is composed of technically independent sub-projects, the Project will be divided into many lots, and separate contracts will be made for each lot. This is applicable to the construction of water conveyance canals.

6-2 Operation and Maintenance of the Project

(Responsibility)

Upon completion of the construction phases, the NSDO is responsible for the operation and maintenance of the water conveyance system, the water management system and the main irrigation and drainage systems. On-farm irrigation and drainage facilities will be operated and maintained under the responsibility of the settlers.

The objectives of the Project could be achieved only with the full cooperation of the agricultural services outside the NSDO's administrative control, as well as the cooperation of the private entities concerned; therefore, the NSDO will be responsible for coordinating their cooperation.

(Organization)

The NSDO would establish an operation and maintenance sector in the head office. The director of the section is responsible for operation and maintenance of the infrastructure and coordination with the agencies concerned.

The NSDO will establish the sub-master station in Kantara and the zonal offices in the project area for better water management. The water user associations will be organized at a rate of one association to 100 feddans for the small farmers and graduate farmers under the supervision of the NSDO. The NSDO will also establish the North Sinai Agricultural Development Center with the branch office in the project area for intensive backup for the small farmers and graduate farmers.

7. PROJECT COST

(Construction Cost)

The construction costs are estimated based on the work quantity, current unit rates employed in NSDO projects, price quotations from manufacturers, and the proposed implementation schedule. Price escalation contingencies are added to the construction costs. The total construction costs amount to 4,521 million LE, of which the base costs are 3,906 million LE at a 1996 price level. A foreign currency exchange rate of US$ 1.00 = LE 3.389 is applied.

Summary of Construction Costs in Million LE

Cost Items	Foreign Currency	Local Currency	Total
1. Water Conveyance and Water Management	559	630	1,189
2. Land Reclamation and Irrigation/Drainage Systems	201	588	789
3. On-farm Irrigation and Drainage Facilities	345	314	659
4. Agricultural Development Supporting Services	35	41	76
5. Settlement and Social Infrastructure	308	629	937
6. Agro-industries	100	70	170
7. Administration and Engineering	29	57	86
Base Cost (1 - 7)	1,577	2,329	3,906
8. Price Escalation Contingencies	197	418	615
Total Cost (1 - 8)	1,774	2,747	4,521

(Operation and Maintenance Costs)

The operation and maintenance costs include the administrative expenses, the costs of maintenance of the engineering facilities, the cost of electricity, and the cost of replacing pumps and other equipment. The annual operation costs are estimated at 105.4 million LE, or LE 950/feddan net, of which the power cost for the Pumping station NO.7 shares 33.4 million LE (32% of the total costs).

8. PROJECT EVALUATION

8-1 Introduction

The present project evaluation has a core objective to verify the impact for implementation of the North Sinai Integrated Rural Development Project from the view point of the national economy. Apart from this economic evaluation, financial analysis on the basis of profitability at farm level was carried out.

8-2 Economic Evaluation

The measure used for economic evaluation is the Economic Internal Rate of Return (EIRR) that is commonly applied for evaluation of development projects.

(Project Benefits)

The quantifiable benefits accrue from agricultural crop production as well as from agro-industry and marketing system development. The farm-gate prices of traded commodities are converted to the economic farm-gate prices, while the financial farm-gate prices of the non-tradable commodities are assumed to represent the economic farm-gate prices. The production costs of farm operation comprising essential farm inputs are converted to economic costs with necessary adjustment by means of shadow prices and exclusion of transfer items.

The agricultural benefits reaches LE 576,833 thousand, and the benefits generated from the operation of agro-based processing and marketing are LE 84,572 thousand at the full development stage.

(Project Costs)

Of the project cost components, only such items as directly related with generation of project's tangible benefits are identified as cost components in the base case of project evaluation; that is, the costs for settlement and social infrastructure are ruled out from the base case of the project evaluation. The local currency portion of the costs are converted to the economic costs. The recurrent costs and replacement costs are also corrected in the same manner.

(EIRR and Sensitivity Test)

The project would face various risks at the time of its implementation and operation, and a sensitivity analysis is conducted to examine how the project's EIRR would be affected. The result of economic evaluation is summarized below:

Summary of Economic Evaluation

Factors Subject to Variable	EIRR (%)
Base case	11.25
1) Total project cost hiked by 10%	10.30
2) Overall benefits reduced by 10%	10.20
3) Combination of 1) and 2)	9.62
4) Construction works prolonged to 5 years	10.13
5) Inclusion of the cost for social infrastructure	9.16

It is concluded that the implementation of the proposed project is justified from the economic viewpoint, because the estimated EIRR is superior to an assumed opportunity cost of capital of 10% in Egypt.

8-3 Financial Analysis

(Model Farm)

The financial analysis is carried out through farm income analysis on nine model farms established in accordance with social categories of settlers and farming patterns as summarized below:

Model Farms

Model	Category of Settler	Land Size (Fed.)	Farming Patterns
1	Large Scale Investor	748	Fruits production
2	Large Scale Investor	748	Cattle fattening
3	Large Scale Investor	748	Dairy farming
4	Large Scale Investor	748	Perennial crops production
5	Small Scale Investor	70	Perennial crops and fruits
6	Small Scale Investor	103	Cattle fattening and vegetables
7	Graduate	10	Perennial crops and fruits
8	Graduate	10	Vegetable and cattle fattening
9	Small Farmer	10	Vegetable and cattle fattening

(Land Allocation)

Assumptions are made with respect to land allocation as follows:

1) Price of land
- Small farmer and graduate : LE 3,000/feddan
- Investor : LE 10,000/feddan

2) Terms of payment
- Small and graduate farmer : Equal installment for 15 years
Interest rate of 6% per year
- Investor : Advance payment of 10%
Equal installment for 10 years
Interest rate of 6% per year

3) Housing : Houses are prepared by the settlers.

4) Operation and maintenance
- Main system : Not charged to settlers
- On-farm facilities : Settlers to bear

(Financial Evaluation)

It is predicted that the farm operation will result in deficit for some years from the commencement of farming, and accumulated debt will not be written off for some years; the year when accumulated debt is written off is defined as the turning year. Indicators relevant to financial analysis of the model farms, in which annual surplus gives the value after canceling payment for agricultural land and completing repayment for loans, are summarized below:

Financial Analysis

Model Farms	Turning Year	Annual Surplus (LE 1,000)	FIRR (%) over 20 Years
1	10th	4,022	15
2	10th	1,802	14
3	6th	7,808	28
4	6th	2,189	25
5	15th	320	20
6	9th	358	14
7	5th	70	31
8	5th	52	33
9	5th	54	35

8-4 Indirect Benefits

The implementation of the proposed project is anticipated to bring about important side effects; economically it contributes to increasing foreign exchange earning by providing import substitute crops and potential exports, and socially, it will relax over-population in the Nile Delta and generate more job opportunity.

8-5 Environmental Impacts and Recommended Mitigation

(Mitigation Measures)

The mitigation measures proposed to reduce the negative effects of the development on the local environment include:

- Establishment of an inland conservation area to protect local inland vegetation and wildlife of the North Sinai.
- Settlement of Bedouins together with their own people to allow as much as possible preservation of their customs and culture.
- Extending the present action plan for the conservation of archaeological sites during the construction of the first phase of the El Salam canal to include subsequent phases of reclamation.
- Management of water flows and quality by extending the telemetry system presently used for distribution of Nile water.
- Soil and crop management should include irrigation strategies, including leaching, sub soil drainage, land smoothing, appropriate timings of irrigations, etc. to maintain salinity and sodium levels within the tolerance range of the crops.
- Canal maintenance programs should be developed which include biological and mechanical weed control in irrigation and drainage canals, to avoid aquatic weeds.
- Training programs for farmers should be developed to teach farmers about the safe and effective use of fertilizers and pesticides.
- Wind breaks and shelter belts should be installed around the settlements and agricultural fields to provide protection against sand storms and moving sand dunes.
- Sand dune stabilization may be required in the heavy sand dune areas using vegetation, geotextiles, palisades or other methods.

(Monitoring Plan)

Water quality and quantities in irrigation and drainage canals should be monitored at critical locations for the proper management and distribution of irrigation water. Water quality parameters to be monitored continuously include dissolved oxygen, pH, electric conductivity and temperature. Other parameters that should be added to the existing monitoring for the drains are heavy metals, such as cadmium and lead, and pesticide residual levels.

Groundwater flows and quality in the Study area should also be monitored during operation of the project so the impact of seepage flows and drainage water discharge can be determined. This will involve the installation of monitoring wells in the Study area.

A groundwater flow model study should be conducted to predict the impacts of the groundwater seepage and the drainage water discharge via the wadi and other drainage soakage areas of the aquifers in the El Arish region.

RECOMMENDATIONS

1. It is recommended that the proposed integrated rural development project for El Sir & El Kawareer Zone with the area of 135,000 feddans, including the construction of the water conveyance system, should be implemented as closely as possible to the proposed implementation schedule. The primary objective of the project is designed in accordance with the policies set forth by the Government of Egypt that irrigated agricultural development shall start in 2002 covering the 400,000 feddans of land in North Sinai.

   The economic internal rate of return of 11.25 percent is higher than the opportunity cost of capital in Egypt (10 percent), indicating that the proposed project is economically feasible. If the completion of the proposed construction works is delayed by two (2) years, the economic internal rate of return will decrease to around 10 percent. For successful implementation of the project, it is important to complete the construction of the main project facilities by 2002. To achieve timely completion, the Government of Egypt needs to earmark the necessary manpower and budgets to the North Sinai Development Organization for strengthening of its work capabilities.

2. It is recommended that intensive backup should be given to settlers with an emphasis on small farmers and graduate farmers to enable them to enjoy stable farming as envisaged, and assist them in organizing farmer associations such as cooperatives and water user associations.

   The settlers may confront problems regarding their farming before they have attained the full production target, especially since it may take several years to reach this target. The North Sinai Development Organization should provide supporting services for the farmers through the establishment of the proposed North Sinai Agricultural Development Center in close coordination with the Ministry of Agriculture and Land Reclamation and other organizations concerned.

   Major crops proposed are vegetables and fruits, and the prices of these crops are susceptible to fluctuation of market demands. In the new liberalized environment, farmers are expected to follow market signals. Under these circumstances, there is a need to establish a market information system.

3. It is recommended to prepare detailed topographic maps covering the proposed conveyance canal routes and the Study area to enhance the accuracy of project design and cost estimates, and also to initiate the detailed design of the proposed water conveyance system.

   The planning of the water conveyance system is based on the analysis of the existing topographic maps with the scale of 1:50,000 and field reconnaissances. With detailed topographic maps, there are possibilities to modify the proposed canal routes to some extent leading to a reduction of the length of pipelines. Detailed design work should commence immediately for the water conveyance system which includes a large-scale pumping station and steel pipelines requiring large investments.

4. It is recommended that water quality and quantities should be monitored at critical locations, and a groundwater flow model study should be conducted to predict the impacts of the groundwater seepage and the drainage water discharge via the wadi and other drainage soakage areas on the aquifers in the El Arish region.

   Water quality and quantities in irrigation and drainage canals should be monitored for the proper management and distribution of irrigation water. Water quality parameters to be monitored continuously include dissolved oxygen, pH, electric conductivity and temperature. Other parameters that should be added to the existing monitoring programs for the drains are heavy metals, such as cadmium and lead, and pesticide residue levels.

   Groundwater flows and quality in the Study area should also be monitored during operation of the project so the impact of seepage flows and drainage water discharge can be determined. This will involve the installation of monitoring wells in the Study area.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND UNITS

Abbreviations

ASTM	:	American Society for Testing and Materials
AWWA	:	American Water Works Association
BM	:	Bench Marks
BP	:	Beginning Points
DCIP	:	Ductile Cast Iron Pipe
DDT	:	Dichloro-Diphenyl-Trichloro-Ethane
DO	:	Dissolved Oxygen
DRI	:	Drainage Research Institute, Water Research Center, MPWWR
EC	:	Electrical Conductance
EEAA	:	Egyptian Environmental Affairs Agency
EIA	:	Environmental Impact Assessments
EP	:	Ending Points
ERR	:	Economic Rate of Return
FAO	:	Food and Agriculture Organization
FRP	:	Fiberglass Reinforced Plastic mortar Pipe
GARPAD	:	General Authority for Rehabilitation Projects and Agricultural Development
GDP	:	Gross Domestic Product
GMS	:	Groundwater Management Study in Arish-Rafah Plain Area
HCH	:	Hexa-Chloro-Hexane
IEE	:	Initial Environmental Examination
ILO	:	International Labor Organization
IMF	:	International Monetary Fund
IP	:	Intersection Points
ISO	:	International Standardization Organization
JICA	:	Japan International Cooperation agency
JIS	:	Japanese Industrial Standard
MAFF	:	Ministry of Agriculture, Forestry and Fisheries, Japan
MALR	:	Ministry of Agriculture and Land Reclamation
MPWWR	:	Ministry of Public Works and Water Resources
MSA	:	Ministry of Social Affairs
NGO	:	Non Governmental Organization
NPV	:	Net Present Value
NSDO	:	North Sinai Development Organization
O/M, O&M	:	Operation and Maintenance
P.S.	:	Pumping Station
PBDAC	:	Principal Bank for Development and Agricultural Credit
PCCP	:	Prestressed Concrete Cylinder Pipe
PVC	:	unplasticized Polyvinyl Chloride pipe
SAR	:	Sodium Absorption Ratio
SDS	:	Sinai Development Study in Arish-Rafah Plain Area
SP	:	Steel Pipe
TDS	:	Total Dissolved Solids
UNDP	:	United Nations Development Program
UNESCO	:	United Nations Educational, Scientific, and Cultural Organization
USAID	:	United States Agency for International Development
WB	:	World Bank
WHO	:	World Health Organization

Unit

℃	:	degree centigrade
%	:	percent
a.m.	:	ante meridiem (= before noon)
cap.	:	capita
cm	:	centimeter
cm/s	:	centimeter per second
DWL	:	delivery water level
Fed.	:	Feddans
ha	:	hectare
hp	:	horsepower
hr	:	hour
kg	:	kilogram
kg/cm^2	:	kilogram per square centimeter
km	:	kilometer
km/hr	:	kilometer per hour
km^2	:	square kilometer
kw	:	kilowatt
LE	:	Egyptian Pounds
m	:	meter
m/sec	:	meter per second
m^2	:	square meter
m^3	:	cubic meter
m^3/day	:	cubic meter per day
m^3/hr	:	cubic meter per hour
m^3/sec	:	cubic meter per second
$m^3/year$	:	cubic meter per year
MCM	:	million cubic meter
mg/l	:	milligram per liter
mm	:	millimeter
mS/cm	:	microsiemens per centimeter
MSL	:	mean sea level
MW	:	mega-watt
nos.	:	numbers
p.m.	:	post meridiem (= after midday)
pH	:	poetical of hydrogen
ppm	:	parts per million
sec.	:	second
US$	:	US Dollar