APPENDIX G

ENVIRONMENT

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G.1 POLICY, LEGAL AND ADMINISTRATIVE FRAME WORK

G.1.1 Pollution Control and Environmental Management

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 (MPWWR), the Ministry of Health, and the Ministry of Interior (MOI).

The Ministry of Health and the MPWWR have the major responsibility of managing and preserving the quality of the country's water bodies. The MOI is responsible for executing the law and removing any violation. The Ministry of State for Housing and Reconstruction is responsible for the provision of treatment facilities for water and waste water for domestic and industrial purposes within cities, towns and villages.

In 1982 the Egyptian Environmental Affairs Agency (EEAA) was created under the auspices of the Minister of Cabinet Affairs. The authority of the EEAA has in reality been limited to the administration of natural protectorates and to representing national interests related to international environmental conventions. Law Number 4 of 1994 on 'Protection of the Environment' defines further the role of the EEAA as an overall coordinating authority with specific responsibilities in terms of setting environmental standards, ensuring compliance with such standards, preparing master plans for environmental management in co-operation with other relevant authorities, establishment and operation of a national monitoring network, implementing pilot projects, as well as compiling and disseminating environmental information. The EEAA is further planning to set up branch offices, one of which will be situated in North Sinai.

The Environmental Action Plan of Egypt was developed in 1992 with assistance of the World Bank. It describes the severity and diversity of the environmental problems in Egypt. The action plan is a multi sectoral effort involving sectoral ministries, research and educational institutions, as well as non governmental organisations. Sources of pollution are identified The Action Plan calls for a comprehensive long term action programme to reverse the on-going deterioration of Egypt's environment and depletion of its limited resources. On of the main objectives is to expand and strengthen monitoring activities regarding the water quality of Nile water, groundwater, and drainage water.

The EEAA is presently also preparing an Environmental Profile for North Sinai which will be completed at the end of 1996.

G.1.2 Environmental Legislation

Several laws pertinent to the environment have been passed in Egypt recent years, Law Number 93 of 1982, Law Number 38 of 1967, Law Number 74 of 1971 and Law Number 48 of 1982. The latter law deals with preserving water quality of all receiving water bodies and gives the MPWWR the responsibility of enforcing the law along with the MOI.

Law Number 48 on Protection of the River Nile and Waterways from Pollution
Although Law Number 48 was enacted in 1982, it has not yet been fully enforced, due to the unrealistic phasing of discharge reductions to meet the standards. Included are water quality standards for:

- Fresh water bodies receiving treated industrial effluent
- Drainage water to allow mixing with fresh surface water bodies
- Brackish or saline surface water bodies including drains which receive effluent

and discharge standards for:

- Treated industrial effluent discharged to fresh water bodies and groundwater
- Treated industrial effluent discharge to fresh water bodies for discharge quantities less than 100 m^3/s
- Sewage and industrial effluent which discharge in brackish or saline water

Law Number 4 on Protection of the Environment
Law Number 4 of 1994 spells out the powers of the EEAA. It also includes the provision of setting up an Environmental Protection Fund which collects funds from Government, donations, as well as fines and compensations for environmental damage. Further it includes sections on protection of land, air and water pollution. Procedures for Environmental Impact Assessment (EIA) are also included. Although the law specifies legal enforcement and penalties including permitting procedures, in reality the success of the EEAA in enforcing the law requires collaboration with a number of line ministries. Law Number 4 also includes penalty provisions for non compliance with Law Number 48.

G.1.3 EIA Capability

A provision for the assessment of environmental impacts (EIA) is included under Section One "Protection of the Land Environment from Pollution" of Law Number 4. EIA's are required for "establishments requiring licenses". Establishments are defined in Annex 2 of the regulations, and infrastructural projects such as irrigation projects are included on this list.

An EIA for the development of the North Sinai was completed in 1992 by Euroconsult and Pacer and Darwish Engineers with assistance from the World Bank. This EIA covers the five zones to be developed in the North Sinai east of the Suez Canal, including zone 5 (El Sir and El Kawareer zone) the study area of this study.

G.1.4 EIA Procedure

The environmental impact of an establishment, according to Law Number 4 is evaluated by the administrative or licensing authority as part of the licensing procedure. When an EIA study is required the report will need be forwarded to the EEAA for comment. The EEAA will then submit suggestions required to mitigate negative environmental effects. The administrative authority will subsequently inform the owner of the establishment of the outcome of the evaluation. The owner has the right to appeal against the EIA and the mitigation measures proposed.

EIA guidelines are being developed at presently for various types of development projects. The draft guidelines are based on the guidelines developed by the World Bank and are planned to be released by the end of December 1996. This report was written using an advanced copy of these guidelines.

G.1.5 Nature Conservation

Egypt has adopted the following international environmental agreements and treaties:

- Mediterranean Action Plan 1975
- The Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona, 1976)
- The Convention on Wetlands of International Importance (Ramsar, 1971)
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)
- The Convention Concerning the Protection of the World Cultural and Natural Heritage (1979)
- The African Convention on the Conservation of Nature and Natural Resources

Lake Bardawil is designated as a protected area under the Wetlands Convention. The Zaranik area adjacent to Lake Bardawil, and the coastal forested region between El Arish and Rafah were declared a natural protectorate in 1985 under Prime ministerial decree No. 1429 under Law 102 of 1983 concerning protected areas. Both of these areas are also listed under the Mediterranean Specially Protected Areas Protocol of the Barcelona Convention in 1976.

G.1.6 Policies and Laws of Land Reclamation

The arable land in Egypt is about 7.5 million feddans (3.2 million hectare) which is 4% of the total land area of Egypt, resulting in a high population density. The Government of Egypt has therefore given priority to distributing the population into various governorates and encourage settlement in the rural areas. The third Five Year Plan covering 1992/93 to 1996/97 includes policy statements with respect to this population distribution, the major goals are:

- To increase the size and activities in the new areas in the Sinai, along the north-west and Red Sea coast, and in the New Valley
- To attract citizens to settle in these new areas and particularly to implement the projects for reclaiming 400,000 feddans in Sinai
- To increase the contribution of the private sector in implementing the development projects in new areas
- To give priority to infrastructure projects in new areas and new cities

The Land Master Plan 1986

This Plan was prepared by the General Authority for Rehabilitation Projects and Agricultural Development (GARPAD) with the assistance of consultants. A gross area of 283,000 feddans was identified in the Sinai as potential irrigable land with Nile water, at pumping heads not exceeding 150 m.

In 1994, the Ministry of Planning set forth the National Project for the Development of Sinai, in the light of urgent need of land resources development. Based on the results of investigations and studies made by various agencies and organisations concerned, top priority of land reclamation has been given to a 400,000 feddan area in North Sinai. Irrigation water will be supplied from the River Nile through the extension of the El Salam Canal called the Shikh Gaber El Sabah Canal.

The Current Settlement Policy

The present Government Policy for the Northern Sinai Agricultural Development Project (NOSAD) has established three principles:

1. "Decongest" the most populated areas of the Delta (Daqahilia, Sharqia and Gharbia) by distributing land to landless farmers
2. Alleviate unemployment and housing problems for graduates, especially those from agricultural institutions
3. Offer land under favourable terms to investors with foreign currency.

North Sinai Development Organisation

The North Sinai Development Organisation (NSDO) was set up as an executive agency for the development of North Sinai under the MPWWR, and is responsible for reclamation and settlement. The NSDO is responsible for construction of all facilities, resettlement planning and operation and maintenance after construction in cooperation with other ministries. The NSDO is based in Qantara-East. The Organisation consists of departments for agriculture, engineering, land settlement and finance/administration, but does not include an environmental department or an environmental officer.

Civil Law

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. It also provides for compensation under certain conditions. Conditions that apply to ownership of desert land are:

- A legal title of land exists as per Law Number 124, 1958.
- The reclaimed or cultivated land has been cultivated for at least one year before issue of the Law Number 124 of 1958. Land reclaimed under rainfed irrigation will not be considered.

- The reclaimed or cultivated desert land has been effectively and continuously farmed, is provided with a permanent water source, and falls within the state plans of reclamation.

In 1987 the North Sinai Governorate issued a decree offering land title to anybody in the region who has cultivated the land for three years. Many Bedouin tribe members however did not register their land as in their opinion customary law covers landownership. Some attempts were made to integrate customary law and civil law and the North Sinai Governorate even gave recognition and power to customary law committees under law 569 of 1980.

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 North Sinai Development Organisation. The resettlement policy of the Government for this project allows for 25% of the settlers to be small scale farmers and graduates, of which 20% will be allocated to the Bedouins.

Although compensation will be given to those Bedouins presently cultivating land in the study area, these decrees seem to contradict the North Sinai Governorate's attempts to integrate civil and customary law, and ignore the fact that Bedouins have used these land for grazing their livestock and camels for many decades.

1.7 Non Governmental Organisations (NGOs)

According to Law Number 32 of 1964 all NGOs must be registered with and under supervision by the Ministry of Social Affairs (MSA). All foreign donations must be channelled through the MSA. As a result the status of NGOs in Egypt is weak. Some of the NGO's active in the field of environment are Friends of the Environment Society, Nile Bank Protection Organisation, and the Association of Youth and the Environment. A national committee for environmental NGOs has now been established with the objective to co-ordinate and support the approximately one hundred registered NGO's in this field.

G.2 DESCRIPTION OF THE PROPOSED PROJECT

G.2.1 El Salam Canal Project

The El Salam Canal Project was initiated in 1979 to allow the development of an area of 620,000 feddans of desert land east of the Nile Delta. The area to be reclaimed includes 220,000 feddans on the west of the Suez Canal and 400,000 feddans on the east side of the Suez Canal. The west bank areas have now been developed and the reclamation of the areas east of the Suez Canal is now in progress. The east bank command area is composed of five zones, of which the last zone to be developed, the El Sir & El Kawareer zone, is covered in this study.

The intake facilities for the El Salam Canal are located approximately 3 km upstream of the Faraskour Barrage on the Damietta branch of the River Nile. The El Salam canal project is implemented in two stages; construction of the first stage, from the intake to the Suez Canal was completed in 1990; the second stage includes construction of a siphon underneath the Suez Canal and an extension of the El Salam Canal, called Shikh Gaber El Sabah Canal. Construction of the second stage is underway (Refer also to Figure G.2.1).

G.2.2 The Proposed Development

General

The Study area consists of 135,000 feddans and is situated at the end of the Shikh Gaber El Sabah Canal approximately 30 km south of El Arish township. The study area has a maximum elevation of 110 meters above sea level and pumping of irrigation water to the command area will be required. The pumping station (PS No. 7) and pipe line are included as part of this study.

Water Conveyance

The originally proposed Pumping Station No. 7 site was planned 86 km east of the intake of the El Salam Canal at the River Nile, which is approximately 36 km from the Study Area.

After further investigation it was decided to extend the canal further by 21.3 km and relocated the Pumping Station closer to the Study Area, approximately 128 km from the El Salam intake. The extended canal, 42.4 km in length, will consist of an open channel, with box culvert sections being proposed over a total length 7.8 km in reaches of active sand dunes to avoid silting up of the canals by drifting sand dunes. The box culvert will have the following dimensions: H 3.8 m x W 3.8 m x 4 rows.

The canal section will be trapezoidal and have a concrete lining. The width of the canal section will be 12 m with an average water depth of 3.3 m and a flow velocity of 0.86 m/s.

Beyond the pumping station four (4) rows of steel pipes with a diameter of three (3) meter will convey the irrigation water further over 12.6 km in southeastern direction to the El Sir & El Kawareer zone. The pipelines will mostly follow the profile of the ground surface. Various alternative routes were assessed (Refer also to Chapter 5 Project Alternatives).

The pumping station will consist of six pump units plus one stand-by pump, providing a total discharge of 52.66 m^3/s and having a total motor output of 72 MW. The pump house plan dimensions are 20 by 80 meters. Regulating reservoirs are proposed near the pumping station for easier operation. These reservoirs will consist of 2 ponds with a capacity of approximately 37,000 m^3.

One main irrigation canal is planned in the actual Project Area, and two secondary canals both which are fed from the main canal and will distribute the irrigation water to the distribution canals. The on-farm irrigation system will consist of a night storage reservoir, to allow 24 hour pumping in the main canals, a booster pumping station, a filtration system, distribution pipes and hydrants located on each service unit (See also Figure G.2.2).

The on farm drainage system will consist of buried pipes to collect the drainage water. The drainage system will not extend over the entire Project Area but will be used in areas where to soil permeability is not sufficient or where there is a danger of waterlogging of the soil. Drainage canals will be made by digging and simply riprap lining will be provided where necessary. Roads are planned along all main canals for ease of canal maintenance.

Irrigation systems such as sprinkler and drip irrigation systems are proposed in the Study Area since these systems are most appropriate and efficient in sandy soils.

Agricultural Development

Crops proposed in this project include potato, onion, tomato, orange, grape, peach and melon. These crops were mainly selected due to their high export potential. Other proposed crops include cereals, fodder crops, oil crops, broad beans, and olives. Crops and cropping patterns have been established for each category of settler and include crop rotation, farm mechanisation and, use of pulse crops to maintain a high productivity. The cultivation area for each farming type has been adjusted so that the water demand by cultivation does not exceed the planned water amount of the El Salam Canal. The pre-requisite maximum water demand is set as 30 m^3 /gross-feddan/day.

Settlements

In total 15 settlements are proposed. Three central villages are planned for the Study Area, each of these central villages will have 4 satellite villages. The settlements will include public facilities such as markets, shops, schools, health units, community centres, public offices, mosques, as well as parks and sport grounds to enhance the living environment. Wind breakers will be provided around the villages to provide protection against sandstorms. Sewage treatment plants and cemeteries will be located outside the settlements. The settlement will provide housing to the farmers, farm workers and those people working in the service industries. The village area will serve 20 to 30 capita per feddan. The total proposed population in the area is expected to be around 115,000 inhabitants.

Utilities provided include drinking water, electricity, wastewater collection and treatment, telephone services, refuse collection.

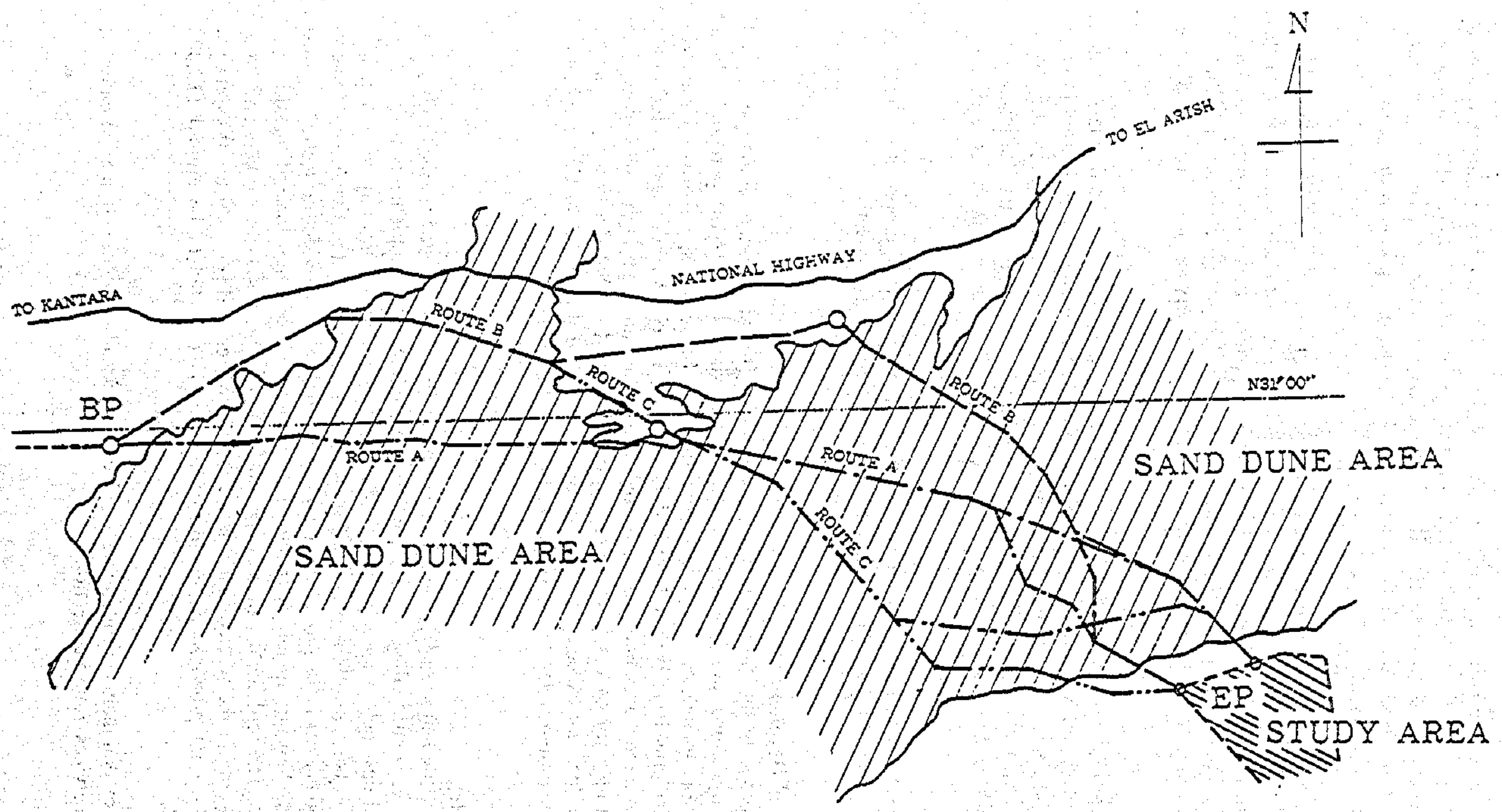

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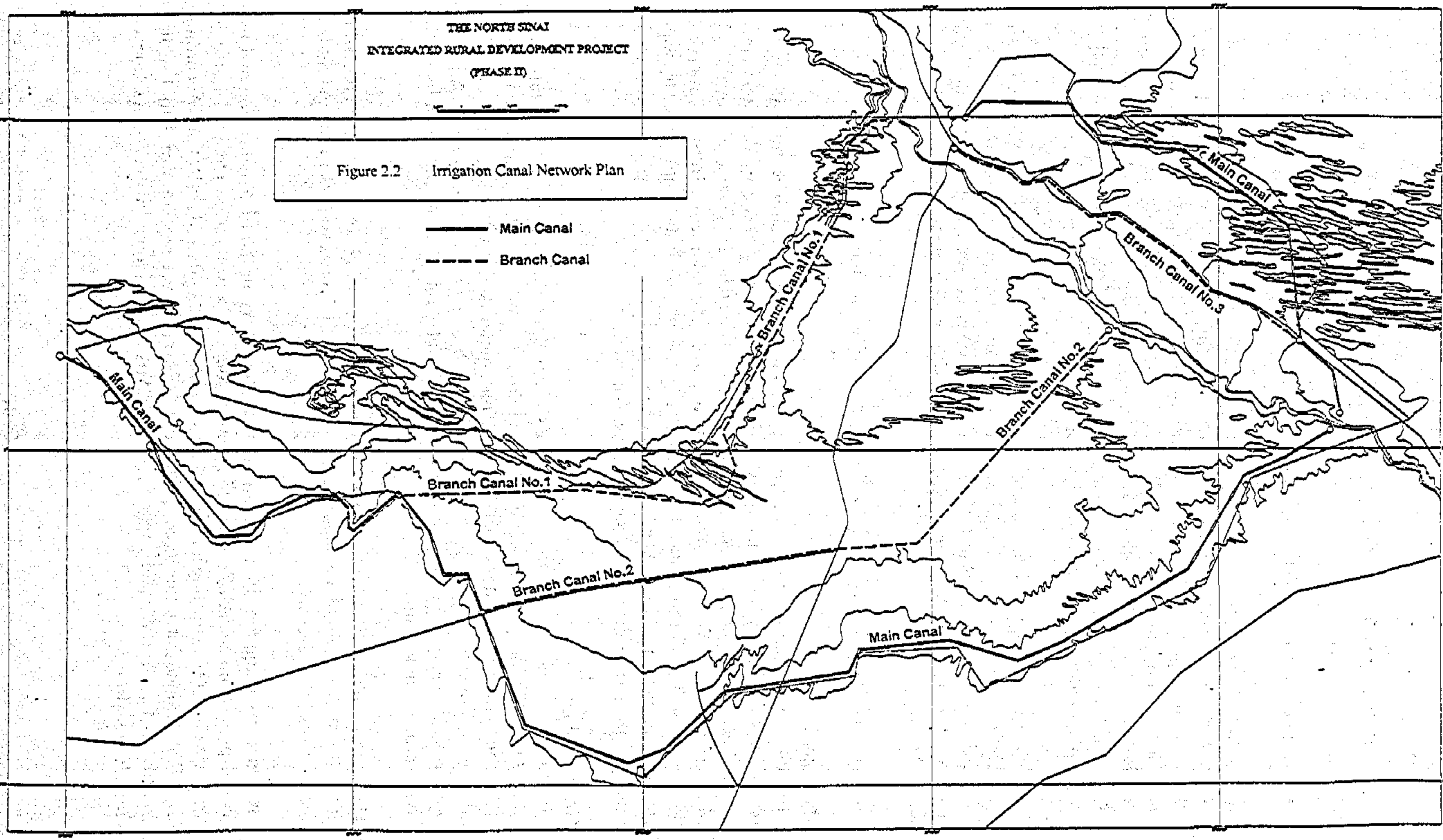
Figure 2.1 - Alternative Water Conveyance Routes

THE NORTH SINAI
INTEGRATED RURAL DEVELOPMENT PROJECT
(PHASE II)

Figure 2.2 Irrigation Canal Network Plan



3 DESCRIPTION OF THE ENVIRONMENT

3.1 Physical /Chemical Environment

Geology and Landforms
The Sinai Peninsula forms part of the African Precambrian Shield that rose between two rifted areas and became tilted down in a northward direction. These tectonic movements took place during the Cretaceous Period. Between the Precambrian and Quaternary periods it was subjected to both long and short transgressions from the Mediterranean sea. There are three physiographic areas: the northern plains, the middle plateau, and the southern mountains with peaks over 2,500 meter.

The Gebels Maghara, which are located south west of the study area, were formed during these tectonic movements. The hill tops consist of Jurassic and Lower Cretaceous rocks with carboniferious layers. Most of the area is however covered with wind formed sand dunes resting on older landforms. North of the site are limestone formations known as Risan Aneiza.

The deposits on the floor of Wadi El Arish consist of fine alluvium river sands.

Hydrology
The complex system of streams (wadis) in the area were originally formed during wet periods in the Tertiary and Quaternary Periods, but are now masked by development of zones of active dunes and coverage of sand sheets. The catchment areas drain towards the Mediterranean Sea. Wadi El Arish stretches out over 250 kilometres from the source to the river mouth (north to south). For most of the year the Wadi does not carry any water since the annual rainfall of 100 mm occurs on average over only 23 days, and most of the rainwater penetrates the soil to recharge the groundwater.

Geohydrology
The coastal Quaternary aquifer system consists of three different aquifers, a top sandy aquifer with shallow groundwater depths, a middle fluviatile gravelly aquifer, and a lower calcareous sandstone aquifer called Kurkar. This aquifer is about 40 meters thick and lies directly underneath the gravelly aquifer with which it is in hydraulic contact. All these aquifers are recharged by occasional rainfall and water runoff from the foothills of the higher grounds in the Sinai.

The deeper Nubian Sandstone aquifer is an older water bearing aquifer system consisting of fossil water. This aquifer extends over a large part of Egypt as well as Libya and Sudan, and receives little discharge.

The Quaternary aquifers are the main groundwater source in the El Arish region and the coastal plain from Sheikh Zuwayid to Rafah. Around 195 wells were recorded in the El Arish area in 1994 extracting a total volume of around 100,000 m^3/day (Ref. 4). According to a JICA Groundwater Resource Study (1992) a water level recession of 1 to 4 m has occurred between 1962 and 1988 in the El Arish region due to over extraction of groundwater (Ref. 5).

Climate

The region has a very arid desert climate with exception of a narrow coastal zone of a few kilometres. This coastal strip has a Mediterranean climate, which is more moderate and characterised by relative cool winters and warm summers with little rainfall. Average rainfall increases in the north easterly direction, from 30 mm/year along the Gulf of Suez, to 300mm in Rafah near the Israeli border. The average annual rainfall in El Arish is 100 mm, which falls predominately between November to February over a average period of 23 days. The rainfall is localised and unreliable.

The maximum monthly mean temperature range is from 19 to 31 °C in the summer, while the minimum monthly mean temperature ranges between 14 to 27 °C during the winter.

Annual average relative humidity varies from 40% in the south to 70% in the north.

The annual average for daily evaporation is about 6.8 mm per day. It ranges from 4.6 mm per day during January to the highest value of 9.1 mm per day during June.

The monthly mean wind speeds in the region vary from 8 to 11 km/hr, mostly blowing from a north and north westerly direction. In spring the wind direction is changeable. During this period the "Khamasin" develops which are strong hot winds from southerly directions, creating dust and sand storms. Windspeeds may reach 50 km/hr or more.

3.2 Biological Environment

Mammals

The fauna found in North Sinai consists mainly of small mammals. The most numerous are rodents such as gerbils and jirds. The population of predators is small and widespread over the area. Thirty five animals species are known to inhabit the entire Sinai. Characteristic mammals of the study area and vicinity are: Fat Sand Rat, Dessert Hedgehog, Hare, Anderson's Gerbil, Simon's Dipodil, Shaw's Jird, Mole Rat, Garden Dormouse, Four Toed Jerboa, Greater Jerboa, Fenece and Sand Fox. None of these mammals in the Study Area region are endemic. Mammals recorded in the Wadi El Arish also include the Dorcas gazelle, this gazelle being listed on the IUCN Red List of Threatened Animals as being "vulnerable"(Ref. 6).

Birds

One of the main flyway paths of migratory births is situated along the northern coast of the Sinai Peninsula. Huge numbers of water birds also overwinter in the area each spring and autumn, especially at Lake Bardawil. To date 230 species have been recorded, most of them migratory birds. Only 7 species were recorded breeding.

There are no endemic resident birds recorded in North Sinai. Characteristic breeding birds of this region are species such as Cream Coloured Courser, Stone Curlew and Hoopoe Lark. Birds of the Bedouin settlements are Black Bird, Palm Dove, Collared Dove, Turtle Dove, Crested Lark, Chukar, Yellow-vented Bulbul, and Palestine Sunbird. The latter three species are restricted to Sinai in Egypt.

Reptiles
Seventeen reptile species have been recorded in North Sinai. Characteristic of the northern Sinai are the tortoise, the agamid lizards, the lacertid lizards and various snake species. Of the agamid lizards the *Acanthodactylus scutellatus* is endemic, while the tortoise such as the *Testudo kleinmanni* and sea turtles reported from Lake Bardawil such as the *Dermochelys coriacea, Chelonia mydas* and *Caretta caretta* are classified by the IUCN as "threatened" (Ref 6).

Invertebrates
Invertebrates include representatives of the Arthropoda: scorpions, spiders, mites and ticks and representatives of Insecta: grasshoppers, beetles, dragonflies, butterflies and moths, as well as a desert snail locally known as the Halazane (*Eremina desertorum*).

Flora
The vegetation of the North Sinai is dominated by sparse to very sparse *Stipagrostis scoparoa* hummock grass land on stabilised sand dunes. Wadi El Arish supports a sparse to very sparse cover dominated by *Zill spinosa* on gravel plains, *Panicum turgidum, Anabasis articulata* and *Zygophyllum album* on sand sheets. *Anabasis articulata* and *Cornulace monocantha* can be found on some gravelly, undulating, valley slopes. No truly endangered species are present in the area (Ref. 7).

The northern coastal region supports a much more diverse flora, due to the relatively high rainfall and cooler climate.

Lake Bardawil and Zaranik Protected Area
Lake Bardawil is an international recognised wetland which covers 650 km^2 and is situqted to the west of El Arish. The Zaranik lagoon is a protected area which is located at the eastern end of Lake Bardewil. The hyper saline lagoon has a depth of 1-1.5 meter and is separated from the Mediterranean Sea by a sand bar. The main habitats identified at Zaranik are salt pans, mud flats, marine open water and sand dunes.

The most numerous of all migratory birds in the lake area is the Garganey (*Anas querquedula).* Up to 200,000 "individuals" have been counted in autumn. Other waterfowl species are the white pelican (*Pelcanus onocrotalus*), herons, gulls, terns and waders. Resident and breeding avifauna is limited. There are, however internationally significant numbers of kentish plover (*Charadrius alexandrius*) and little tern (*Sterna albifonds*) breeding at Zanarik and Lake Bardewil. Other bird species are the crested lark (*Galerida cristata*) the hoopoe lark (*Alaemon alaudipes*).

Flora in the area is generally sparse, and the salt marsh vegetation is dominated by *Halocnemon strobilaceam* which occur in the most saline areas adjacent to the lagoon often in thick patches. On higher less saline ground the succulent *Zygophyllum album* can be found.

3.3 Socio-Cultural Environment

Townships and Settlements

The majority of the 234,000 inhabitants (1996) of the North Sinai Governorate live in the El Arish region. El Arish has a population of approximately 90,000 people and is the capital of the Governorate. There are five settlements within the Study Area with a total population of approximately 4000, mainly Bedouin people. El Makdaba is the main settlement and has a village administration office. The houses in the villages are constructed from permanent materials such as concrete and brick, although temporary Bedouin shelters were seen in the vicinity of the villages. Public facilities in El Makdaba village include two schools and a health clinic.

Bedouins

The land in North Sinai is divided amongst various Bedouin tribes. The tribal areas of five Bedouin tribes are affected by the North Sinai Integrated Rural Development Project. These are the Sawarka, Belli, Tarabeen, Ahiwat and the Ahwatat tribe (Refer to Figure G.1). Of these, the Tarabeen and the Ahiwat tribes are likely to be more affected since the study area covers predominately their tribal land. The land is used 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.

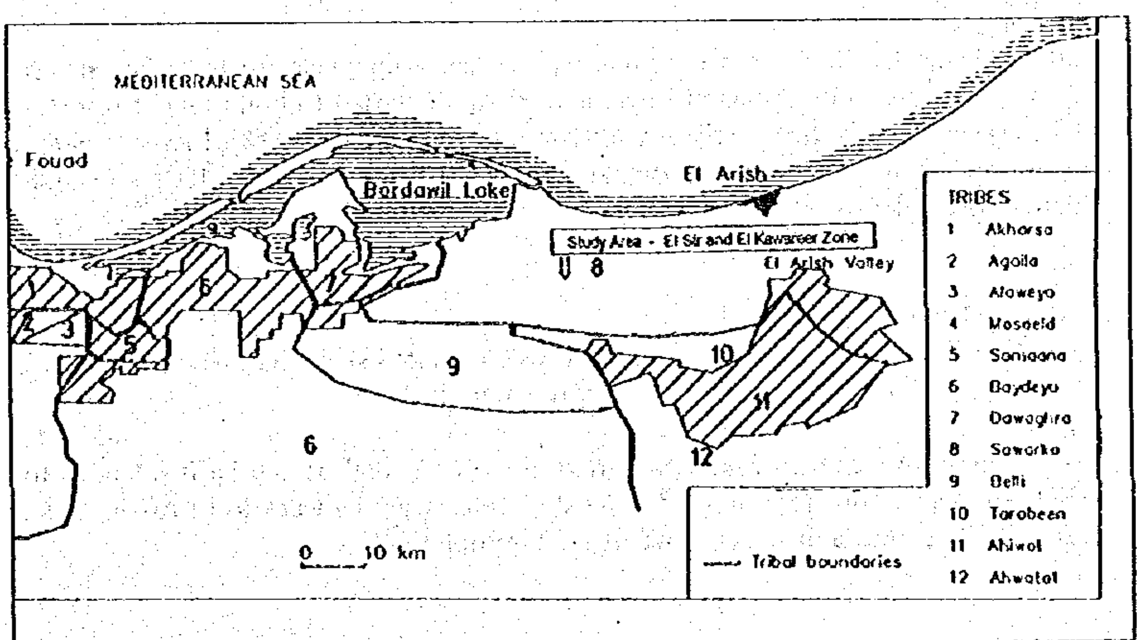


Figure G.3.1 Tribal Areas in North Sinai

Agriculture and Fisheries

Irrigated lands are located in the Wadi El Arish area south of the El Arish township and El Maghara region using groundwater sources. Agricultural crops include olives, almonds, fruits and vegetables.

Lake Bardawil is considered to be one of the most productive fishing areas in Egypt. The local Bedouin Sawaraka and Akharsa tribes are historically involved in fishing the lake. Fish species caught are sea bass, mullet, sole fish, sardine, crab, catfish and dogfish.

Livestock

Goats and sheep are kept by the Bedouin tribes for their wool, while camels are used for transport. Camels also represent a source of wealth, status and income. Grazing of camels is practised by the male members of the tribes and often requires many days out in remote grazing areas. The number of camels, however, has been reducing due to the increasing trend for Bedouin to settle and replace the camel by motor vehicles as the mode of transport.

The grazing and herding of goats and sheep is the role of women, mostly the younger, unmarried girls or the elder women. As agriculture is intensifying, livestock is being kept in yards in order to stop them destroying the crops. This results in a increasing reliance on fodders which are expensive. The overall cost and inconvenience, as well as the decreasing demand for wool products, is a major factor in the reduction of herds in the region

Tourism

Until 1980, the Mediterranean coastline was virtually undeveloped but since the early 1980's developers from mainland Egypt and El Arish started to build tourist resorts and hotels, especially west of El Arish. Apart from its attractive beaches El Arish has tourist attractions such as a heritage museum, zoo, various historic ruins and fortresses and the Zanarik protected area.

Mining and Industry

The industry and mining sector in Sinai is still very limited scale. Salt winning takes place 35 km west of El Arish where a salt factory was built in 1991.

Coal mining near Gebel El Maghara started in 1991. A total of 200 ha is intended to be mined using open mine techniques. The coal is transported by truck to El Arish. The coal reserve at Gebel El Maghara is estimated at 52 million tons.

Sanitation

The treatment plant in El Arish has a capacity of 225,000 m^3/day, the sewerage system is presently being extended to connect other parts of the town to the plant.

The settlements in the study area do not have centralised sewerage systems and usually rely on pit latrines.

Solid waste collection and disposal is only organised in the main towns such as El Arish.

Water Supply
El Arish is supplied with drinking water from Qantara by a 120 km long pipeline which runs along the main road from Qantara to El Arish and has a capacity of 32,500 m^3/day. Water shortages aro however common and a second pipeline is planned to increase the capacity with an additional 60,000 m^3/day. The villages El Koreah, El Makdaba and Awlat Ali in the study area are supplied with drinking water via a pipeline from El Arish. This line has however been out of service for 6 months due to water shortage in El Arish, and drinking water is now provided by tanker.

Power Supply
El Arish has three power stations with a total capacity of 80.6 MW. The villages El Koreah and Bir Lefen in the Study area are supplied with power from El Arish while the other villages generate their own electricity using generators. The generators are operated for 6 to 7 hours per day.

Transportation
The main access to the El Arish region is provided by the main road between Qantara and El Arish, which also serves villages along this road. There are buses and taxi services that run along the main road between the towns and villages. Car transport or car sharing is the most frequently used mode of transport, especially between the settlements off the main road were no public transport is available.

Regular domestic flights from El Arish airport only operate during the summer period to cater for tourists.

El Arish port used to be predominately a fishing boat port, but the first phase of a port renovation plan, costing LE. 3.5 million, has be now been completed to allow the port to cope with the steadily increasing coal exports coming from El Maghara coal mine. A second stage of the port development is expected to be completed within three years.

Archaeological Sites and History of the Region
The coastal strip of North Sinai between Port Said and Gaza is and important land bridge between the different civilisations of Africa and Asia. Settlements can be found originating from various periods consisted of towns, villages, military fortresses, checkposts, caravan serais and other temporary settlements which were located in the region between Calcolithic times in the fourth millennia BC and the Middle Ages. The following periods can be distinguished (Refer to Figure G.3.2):

Pre-dynastic Period to Middle Kingdom (4000-1580 BC)
Around 250 sites dating from the pre-dynastic period have been uncovered mainly along the main road from Qantara to Rafah.

New Kingdom (1560-715 BC)
The largest concentration fo New Kingdom sites is reported in the north western corner of Sinai, between Port Said, Romana and Qantara. A fort from the same period was

discovered in Haruba 12 km east of El Arish. Fortifications and four granaries were also found nearby Bir El Abd.

Saite Period (525-332 BC) (Persian)
Remains of this period were found near Tell el Heer, which includes an unusually large fortress which is believed to be the Migdol fort where Jewish refugees found asylum during the Babylonian invasion. Other remains include parts of Pelusium, a city that used to be located on the mouth of the Pelusium Nile Branch (the present Tina Plain Area). The city was founded in the late 6^{th} or early 5^{th} Centry BC. The Pelsium branch has since silted up.

Greek and Roman Period (332 BC - 324 AD)
During the Greek and Roman period the eastern delta was densely populated. One of the most important sites is the ancient town of Ostracine situated near the east side of Lake Bardawil. The ruins of Kasserwit near Katia include residential quarters, cemetries and a Nabateen temple complex. Other Roman ruins believed to be fortifications were discovered further east of Katia, and south of El Roda. Most of these sites have not been excavated.

Byzantine Period (324-638 AD)
A Byzatine church was found near the great basilica of Ostracine. The church is well preserved and was constructed in the 5th Centruy.

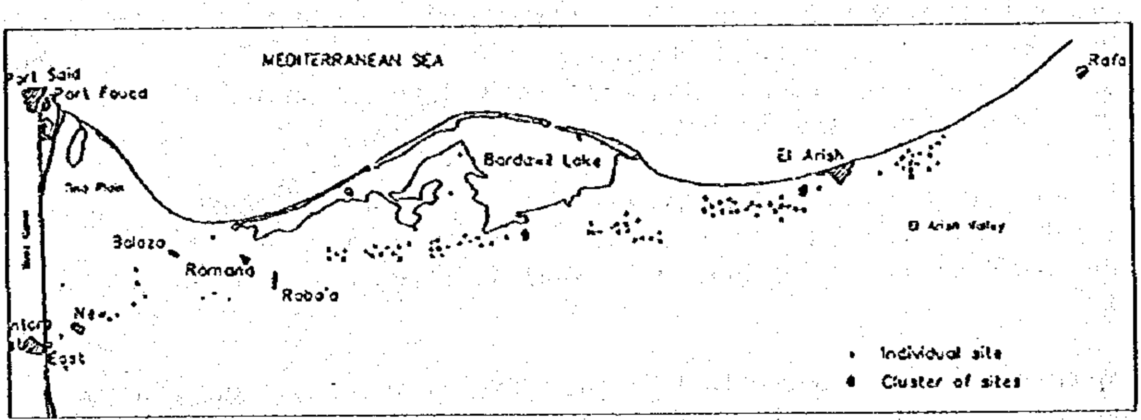
Arab Period (638-1260)
The Arab Period starts with the conquest of Sinai in 638 led by Amr Ibn El As. About 200 sites are known from the Arab Period, which are scattered in a zone from the coast to 25 km inland.

Middle Ages - Crusaders
Crusaders also left some traces in North Sinai. The leader of the first crusade Baldwin I king of Jerusalem in 1100 gave his name to Lake Bardewil, which is a deformation of Baldwin. He led and expedition to Egypt in 1118 but died in El Arish on his way back.

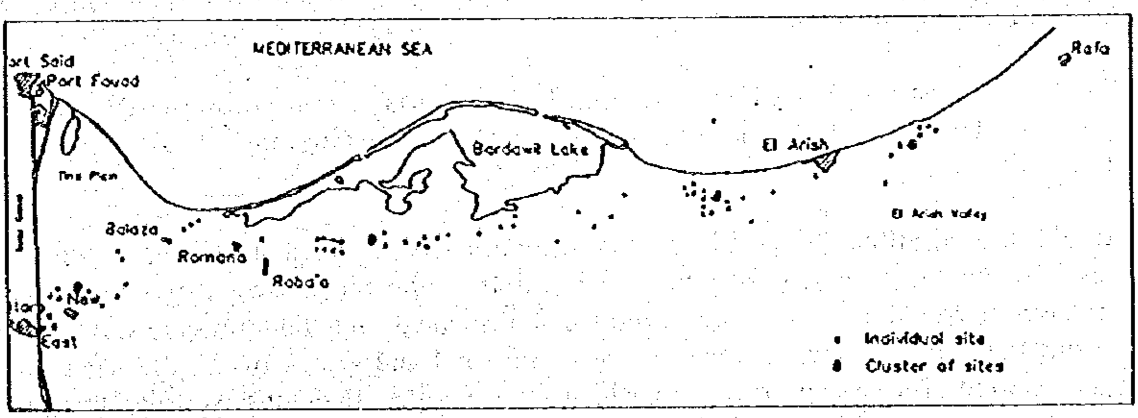
Future Developments in North Sinai
The Sinai is rich in resources which the Government of Egypt is planning to develop on a national, regional and local level. Resources discovered in the North Sinai Governorate between El Arish and Rafah include coal and sulphate.

The National Project for the Development of the Sinai (1992) referred to the development of free zones for small scale industries in Sinai, one of which will be located in El Arish. In total 100 hectare (240 feddans) is designated for various industries including agricultural industries.

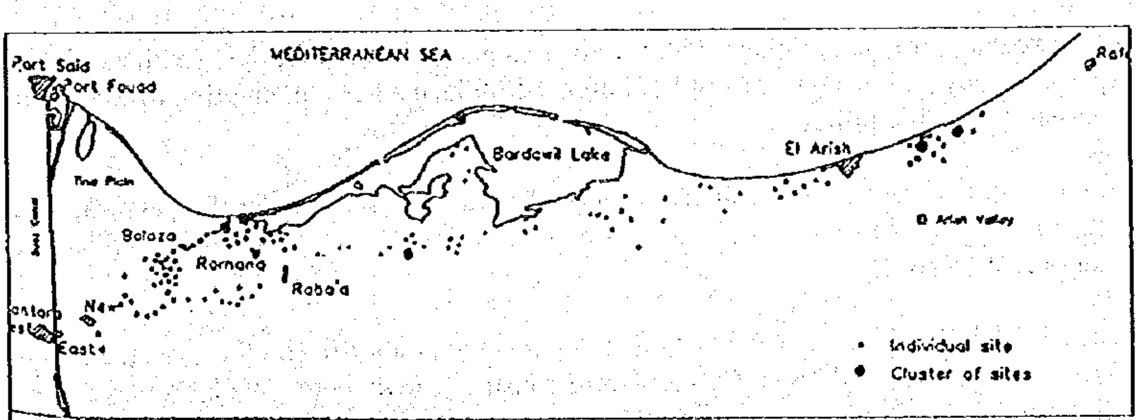
Figure G.3.2 Major Archeological Sites in North Sinai (source: Ref. 7)



Early Bronze Age Sites



New Kingdom Sites



Iron Age and Persian Period Sites

G.3.4 Environmental Site Conditions of the Study Area

The Study Area

The study area is located approximately 30 km southwest of El Arish and is part of a army protection zone. Special army permission is required for foreigners to enter this area (See Figure G.3.3).

The settlement of Bir Lefen is located in the most northern part of the Study Area but just outside the army protection zone. The main road south from El Arish divides into two main sealed roads at Bir Lefen intersecting the study area in south western and south eastern directions. Both roads connect with the east west road from Abu Aweigila near the Israeli border to Ismailia at the Suez Canal.

Some drip irrigation fields with olive trees are located along the "south west" road just past the military check point. Undulating sand dunes with very spares vegetation were observed along the west side of this road, while the land on the east side was more or less flat.

Approximately 30 km south of Bir Lefen lies the village of El Resan, and 5 km further an army camp both on the east side of the "south west" road. A concrete plant is located in this vicinity on the west side of the road. In the distance on the west side lie the Risan Aneiza lime stone hills.

The "south west" road is extensively used by heavy trucks transporting coal mined at Gebel El Maghara to El Arish. Gebel El Maghara is a mountain range 70 km west of El Resan.

An old disused military airport is located approximately 45 km south from Bir Lefen. It was built by the Israelis during their occupation of the Sinai. Heaps of scrap metal, perceived to be old weaponry, and partially demolished concrete buildings are still present on the site, but the runways were covered with sand and grown over with vegetation. Camels were also seen grazing here which indicates that Bedouins were living in the vicinity, however no Bedouin shelters were observed.

El Makdaba is the main village in the study area and is located on the "south east" road, approximately 45 km south east of Bir Lefen. El Makdaba has a population of 900 people consisting of 150 families.

Some Bedouin shelters and cultivated plots of land were seen along the southeast road near El Koreah. El Koreah is located approximately 15 km south east of Bir Lefen on the "south east" road.

The El Arish Wadi is a dry river bed that intersects the Study Area on the east side running from south east to north west. Culverts were constructed where the Wadi crosses roads to allow the winter rains to pass. The road embankment of one of these culverts near the south east corner of the study area was completely eroded, probably due to flash floods. A new road was constructed alongside the culvert on the floor of the Wadi valley without flood protection.

Water Conveyance System

The originally proposed site of pumping station No. 7 is 86.5 kilometres east of the Suez Canal, and approximately 5 km south west of Misfaq village, which is located on the main road from Qantara to El Arish. The area consists of undulating sand dunes, some of them active, with sparse vegetation. Sand dunes varied in height between 20 to 40 meters.

Some Bedouin shelters as well as some permanent concrete structures were seen near the proposed canal route approximately 80 km east of the Suez Canal. Access to the exact location of Pumping Station No. 7 was difficult since no roads existed in this area. Active sand dunes were visible at one of the side roads which crossed the proposed canal route. The road was partially covered by active sand dunes.

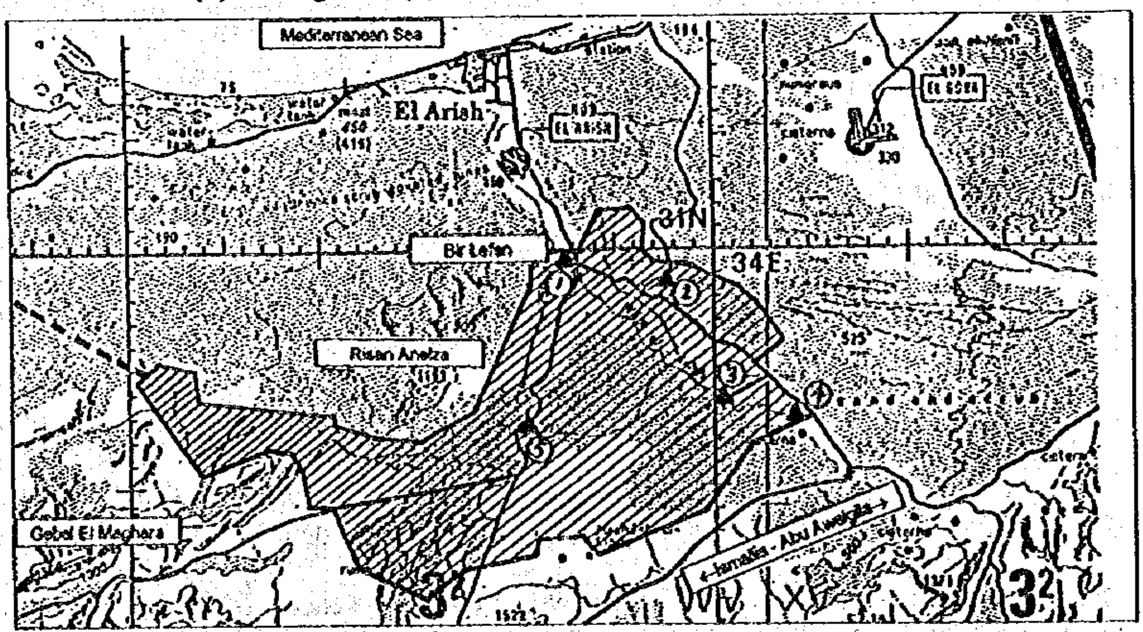
An alternative pumping station site was selected approximately 20 kilometres further east from the original site, and approximately two kilometres south of El Mazor village. Flat plains and sand dune belts succeed each other at intervals of about 10 km in this region.

Isolated plots of vegetables were present in the vicinity of the proposed alternative canal route near El Roda. These plots were irrigated using a drip system and portable pumps. Groundwater was used as water source.

A Roman ruin site is situated a few hundred meters upstream of the newly proposed pumping station site. Ceramic remains believed to be from old pottery were found scattered over a wide area of the valley bottom.

The undulation of the sand dunes increases in severity when moving east towards the Study area.

Figure G.3.4 Existing Villages in the Study Area: (1) Bir Lehfen, (2) El Koreah, (3) El Magdaba, (4) Awlat Ali, (5) El Resan.



G.4 SIGNIFICANT ENVIRONMENTAL IMPACTS

IMPACTS DUE TO ESTABLISHMENT LOCATION

G.4.1 Population Redistibution

The project will have a positive impact on the population distribution in Egypt and will encourage settlement in rural areas and relieve areas with a high population density such as the Nile Delta.

G.4.2 Development of a New Habitat

The Study area, after development, will act as a large cultivated feeding habitat and resting area for significant groups of resident and migratory birds. Since the project area is located on one of the main fly routes of a large number of migratory birds the new agricultural lands are likely to attract numerous bird species. This is considered a positive impact.

G.4.3 Stabilisation of Sand Dunes

The reclamation of desert land and the development of wind breaks and shelter belts around the agricultural lands and settlements will have a positive impact on the micro climate in the project area and will reduce sand erosion and desertification and will result in stabilisation of moving sand dunes and is considered a positive impact.

G.4.4 Loss of Historic Sites

Two known archaeological sites will be affected by the project. One historic site is located on the proposed canal Route C-B2 south of El Roda. It consists of a ruin of a Roman fortification dating from the period 332 BC to 324 AD and covers a total area of approximately 60 hectare. The other site is situated near the south - western boundary of the Study area on the originally proposed route of the main irrigation canal (Refer to Figure G.4.1).

Alternative routes of the irrigation canals were extensively analyses during the feasibility study, and Route B-C2 was considered the preferred and most economical route. Further investigations in rerouting sections of the preferred Route B-C2 during the detailed design stage to avoid the destruction of the historic sites are recommended.

Other unknown historic sites could be discovered during the course of the excavation of the canals, and the development of an archaeological preservation management plan is recommended to avoid destruction of these sites.

G.4.5 Loss of Natural Habitat

The reclamation of 135,000 feddans in North Sinai will reduce the area of natural desert land and wilderness. As a consequence native wildlife will loose their natural habitat and move to adjacent desert lands. This could result in an increase in pressure on the remaining wildlands. most of the native flora will be removed during reclamation. The project will therefore have a negative impact on the local flora and fauna populations.

G.4.6 Employment and Housing

The project will result in an increase in employment in the region. It will not only provide new job opportunities during operation of the irrigation scheme, but new jobs will also be created during the construction phase of the project. It will further alleviate housing problems experienced in the most populated ares such as the Nile Delta.

G4.7 Impacts On Local Population

Previous Studies on Bedouins Issues
In 1989 GARPAD organised a study in cooperation with Atkins Land Water Management in which it examined the views and opinions of the Bedouins in the region related to the development of irrigation projects in the North Sinai. Data was collected via questionnaires which were filled in after personal interviews with the Bedouins (Ref. 17).

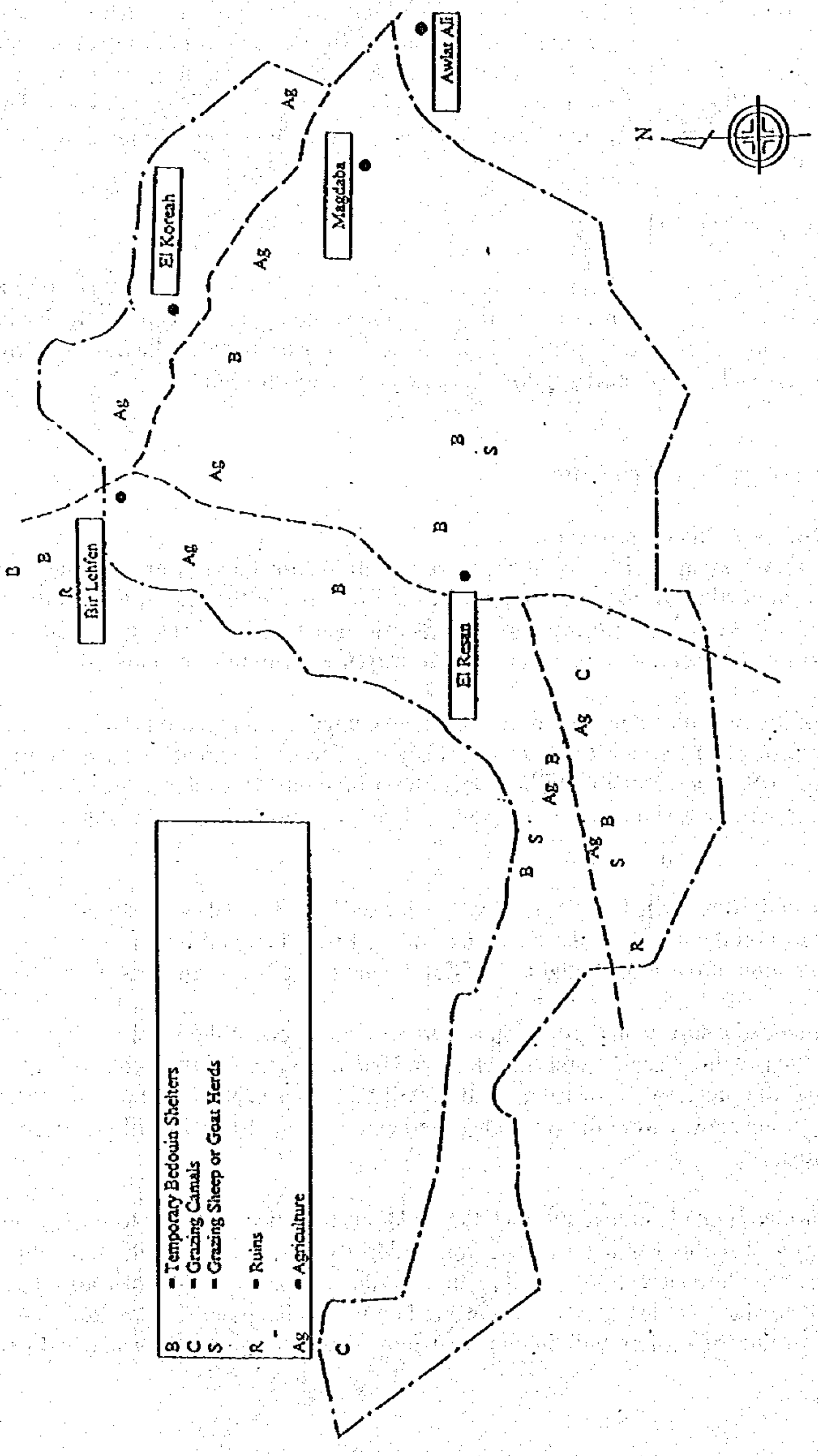
A majority of the Bedouins (66%) favoured that land compensation methods were handled individually instead of through tribal chiefs. They considered 7 feddans as the average land required to make a reasonable living. Only 18% of the interviewed mentioned that, to succeed as farmer in a reclaimed area the settler should be allowed to settle with his own people.

An in-depth study was carried out in 1992 which looked at the social and cultural aspects and the impacts on the local population, as part of the Environmental Impact Assessment for the reclamation of the 400,000 feddans of desert land in the North Sinai (Ref. 7).

The study included a survey and group interviews with members of the local tribal groups to ascertain the existing customs, conditions, tribal land and water rights. It concluded that the impact on the preservation of tribal culture will be highly negative. The project will accelerate the move away form the traditional Bedouin nomadic lifestyle still practiced in the Study Area.

The study further pointed out that although the Bedouins have been moving to settlements in recent years, that this has been undertaken within their own communities, retaining much of their traditional culture. Preservation of the Bedouin culture has also been possible due to the fact that they were the predominant inhabitants in the study area, however an influx of settlers will in the long term sway this population and cultural balance.

FIGURE G.4.1 Present Land Use in the Study Area



Views of Existing Bedouin Population

Through talks with the local population in the villages during the site visits of the Study Team it was understood that most of the Bedouins that had already settled in the region are interested in the development of the area, and are keen to participate in farming activities once the water is available. Presently most of the Bedouins that have settled in the villages have found employment in the El Arish region, some are involved in seasonal rainfed agriculture and animal husbandry.

Approximately 18 to 20 families are still believed to be nomadic in the region of the study area. Present land use and the location of nomadic Bedouin shelters observed during the field surveys in May and September 1996 are shown in Figure G.4.1.

Compensation of Existing Land Users

The development of other irrigation projects such as the schemes in West Nubariya and New Mit Abu el Kom have in the past resulted in problems with respect to land claims of Bedouins, where the local population tried to forcibly take land that they claimed was theirs. It is therefore important that the local population is consulted in an early stage with respect to land ownership issues. If landownership can not be proved the NSDO will provide a 50% reduction in land price for those farmers that are presently cultivating land in the to be reclaimed areas.

Displacement of Existing Population

The Bedouins that have settled in the existing villages in the Study area may not have to resettle due to the development of the region, but they will have to share their towns with the new settlers moving into the region from other parts of Egypt.

The farmers practicing rainfed farming in the Wadi El Arish region will most definitely loose access to the land they are presently cultivating. Those farmers that can claim ownership of the land under Law Number 148 will be compensated for their loss of land due to the project.

Grazing

Due to the limited amount of water available for livestock in the Study Area, this region can be considered of moderate value to grazing. Grazing practices are also reducing due to the settlement of the local population. The project will further reduce traditional grazing in the region. However some new areas will be opened for limited household grazing such as canal banks.

Livestock grazing is generally not regarded by the national or local governments as an activity that would result in a successful claim to land rights.

Animal Husbandry

The project should lead to improved condition for animal husbandry, including supply of veterinary services, breeding farms, animal sheds, access to fodder and feed and market provisions.

Farming
The canal will provide a regular and better quality supply of water and the use of modern farming practices proposed in the project will enhance the existing practices used.

Income Levels and Employment
The project will provide many employment opportunities during the construction and operation of the irrigation scheme and income levels of locals will rise as a result of the supply of water from the canals to the farms.

Women
Urbanisation of the area will reduce the mobility of women, which are allowed a large degree of freedom under tribal life due to the semi nomadic heritage and protection under customary laws. Better availability and access to drinking water, electricity and other facilities however will help ease the domestic activities of the local Bedouin women.

Infrastructure
Provision of electricity, drinkwater, better roads and transport system will impact positively on the local population.

IMPACTS DUE TO ESTABLISHMENT DESIGN

G.4.8 Availability of Irrigation Water

The following sources provide fresh water for agriculture, industry, navigation and domestic use in Egypt:

	1994/1995 billion m^3	2000 billion m^3
Available from The High Aswan Dam	55.5	55.5
Drainage Water Reuse	4.3	6.3
Ground Water	4.1	6.0
Treated Sewage	0.4	0.6
total	64.3	68.4

Agriculture in Egypt is presently using 53.3 billion m^3 of water and it is projected that by the year 2000 agricultural demands will increase to 57.6 billion m^3, due to an increase in reclaimed land area of 504,000 hectare (1.2 million feddans), which includes the study area of this study. This will be met by further developing drainage water reuse and groundwater extraction, and increasing the reuse of treated effluent.

The total potential of drainage water reuse and groundwater extraction has been determined as 7 billion m^3 for both sources respectively, as suggested in various studies of the water and salt balances of the Nile Delta done by the Drainage and the Groundwater Research Institutes. It is projected that these limits will be reached in 2010.

The total estimated water requirement for the El-Salam Canal Project is 4.45 billion m^3 per year of which 2.11 billion m^3 per year will be taken from the Damietta Branch. The remainder will be obtained by mixing drainage water from the Serw Drain (0.435 billion m^3 per year) and Hadous Drain (1.905 billion m^3 per year) with water from the Damietta. The estimated monthly flows for the project, as provided by the NSDO, are shown in Figure G.4.2.

Figure G.4.3 shows that water shortages occur in May and June when monthly average drain flows (1984-1990) are compared with the estimated monthly water requirement from the drains for the project. This comparison however does not allow for unofficial drainage water reuse along Hadous Drain.

This unofficial reuse of Hadous drainage water became obvious when alternative measuring locations were deployed along the Hadous Drain during a Drainage Water Reuse Project in 1993 (Ref. 8). The flow figures show lower monthly average drain flows resulting in shortfalls in the period March to August, when compared with the design flows for the El Salam Canal Project (Refer Figure G.4.4).

It is recommended that unofficial use of drainage water along the Hadous Drain is discontinued otherwise shortages will occur in the regions further downstream of the El Salam Canal. Shortages can partially be overcome by using additional sources such as the Faraskour Pumping Station. Other sources are presently still under investigation.

Figure G.4.2 Monthly Design Flows for El Salam Project

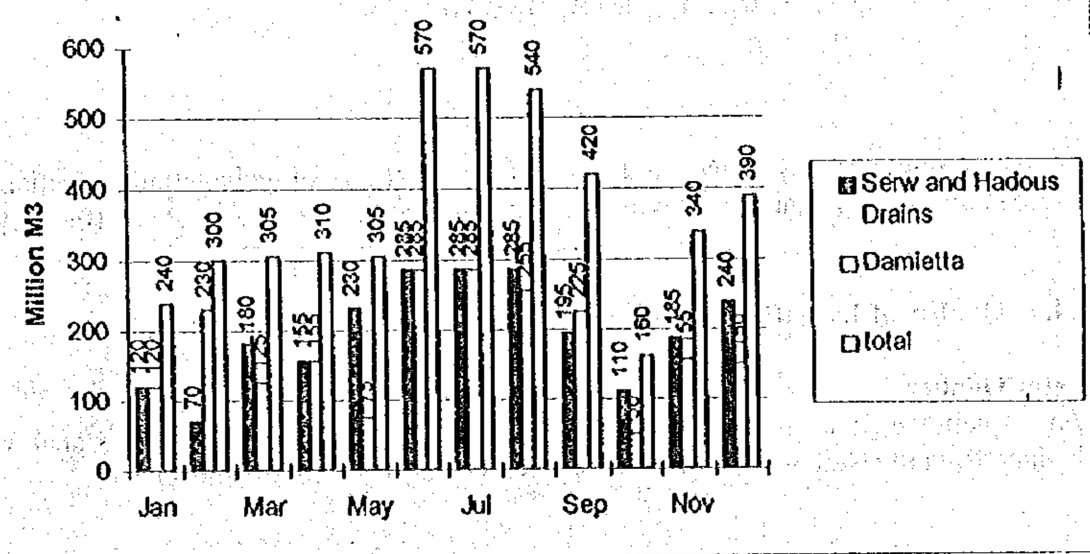


Figure G.4.3 Combined Monthly Flows of Serw and Hadous Drains unoffical reuse of Hadous Drain Water is not Included (Alt 1, Ref 8)

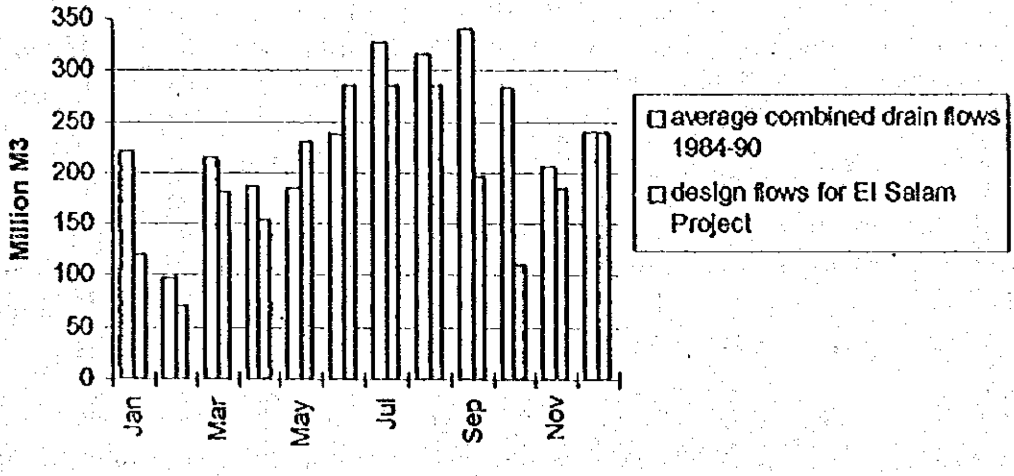
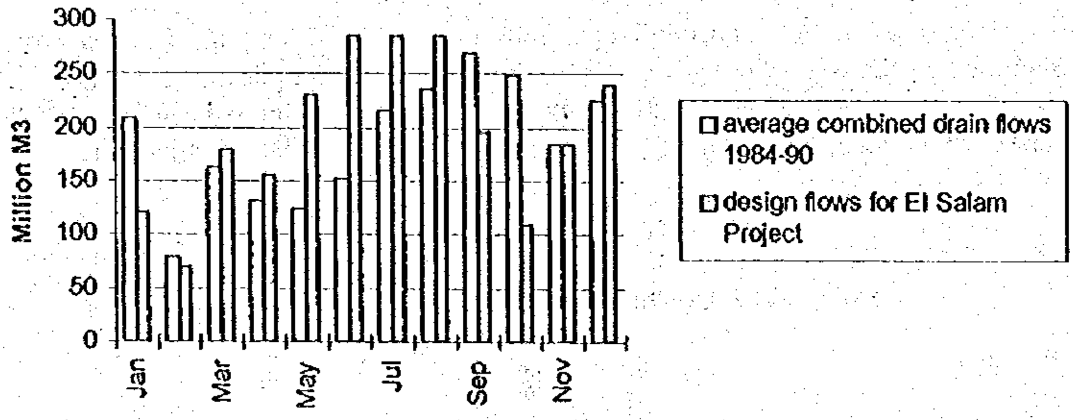


Figure G.4.4 Combined Monthly Flows of Sew and Hadous Drains Allowing for unoffical reuse of Hadous Drain Water (Alt 3, Ref 8)



Alternative solutions may include: reduction of the target area of reclamation, reduction of the area allocated for summer crops and improvement of the irrigation system efficiency.

G.4.9 Quality of Irrigation Water

Water Quality

Water quality data of the various water sources supplying the El Salam Canal was obtained from the National Water Research Center and is shown in Table G.4.1

Table G.4.1 Water Quality Data of the Damietta Branch and Serw and Hadous Drain

		Damietta (1180 km) Sample Point No.34 Upstream Intake				Lower Serw P.S.			Hadous Bridge		
		Aug 1991	Dec 1992	Dec 1993	Jan 1995	yearly average 1990	1991	1992	yearly average 1990	1991	1992
D.O.	mg/L	7.05	7.86	4.88	3.41	-	-	-	-	-	-
Turbidity	NTU	8	16	2.6	14	-	-	-	-	-	-
Conductivity	umhos/cm	710	620	800	500	1600	1520	1630	2770	2500	2790
pH		7.1	7.93	6.61	8.05	7.33	7.16	7.52	7.35	7.15	7.49
Ammonia (NH_3)	mg/L	0.29	0.9	0.2	0.07	-	-	-	-	-	-
Nitrogen (org)	mg/L	0.01	0.07	0.05	-	-	-	-	-	-	-
Nitrite (NO_2)	mg/L	0.022	0.049	0.04	0.03	-	-	-	-	-	-
Nitrate (NO_3)	mg/L	3.3	5.1	7	4	-	-	-	-	-	-
PO_4-P	mg/L	0.066	0.152	0.14	0.18	-	-	-	-	-	-
T-Phosphorus	mg/L	0.238	0.165	0.25	0.31	-	-	-	-	-	-
BOD	mg/L	5.6	1.1	-	5.2	-	-	-	-	-	-
COD	mg/L	13	15	-	12	-	-	-	-	-	-
TSS	mg/L	15	17	8	16	-	-	-	-	-	-
Oil & Grease	mg/L	2.9	3	-	1.9	-	-	-	-	-	-
TDS	mg/L	368	466	480	356	1075	1009	1051	1824	1560	1789
Cl	mg/L	75.66	100.8	81.96	90.6	8.1	7.57	8.09	15.6	14.34	15.43
Sulfates (SO_4)	mg/L	63	50	52.3	34	4.84	6.1	6.85	8.51	9.26	10.25
Carbonates (CO_3)	mg/L	0	0	0	0	0.01	0	0	0.02	0	0.1
Bi-Carbonates HCO_3)	mg/L	178.4	176	183	170	3.62	2.14	1.67	4.59	1.53	2.77
Ca	mg/L	39.67	78	45.6	44	1.69	1.97	2.63	2.67	3.21	3.13
Mg	mg/L	3.8	24	27.36	21.6	4.33	3.98	4.18	7.03	5.41	6.74
Na	mg/L	68.19	69	85	63	10.26	9.64	9.85	18.64	16.23	18.45
K	mg/L	7.31	7.1	24	6.1	0.3	0.22	0.22	0.37	0.28	0.24
Coliform	No./100mL	500	2000	1200	1800	-	-	-	-	-	-
Fecal Coliform	No./100mL	25	1000	600	650	-	-	-	-	-	-

* source: National Water Research Center

The sampling point (34) on the Damietta Branch is located just upstream of the El Salam Canal intake and the data would therefore be representative of the water taken for irrigation.

Water quality data collected on 13 and 17 May 1996 by the study team is shown below:

	Damietta*	Serw P.S.*	Hadous Bridge**
pH	7.8	7.54	7.70
E.C. umhos/cm	0.6	1.69	3.13
D.O.(mg/L)	3.84	4.97	3.19
Temperature (°C)	27	27.9	25.7
Salinity (PPM)	200	730	1500

* average of three measurements
** average of two measurements

Drainage Water Mixing

Drainage water can be defined as the excess irrigation water which flows on the land surface or through a subsoil drainage system. Thus, it contains soluble salts and possibly residues of pesticides and fertilisers. The salinity level of the drainage water could therefore become the limiting factor on reusing drainage water for irrigation.

Table G.4.2 Electrical Conductivity and Salinity Values of Irrigation Water

	Serw		Hadous		Damietta			After Mixing	
	Design Flow	E.C.** average 1984-90	Design Flow	E.C.** average 1984-90	Design Flow	E.C. average 1991-95	Q total	E.C.	Salinity
	Million M3	dS/m	Million M3	dS/m	Million M3	dS/m	Million M3	dS/m	PPM*
Jan	30	1.99	90	2.69	120	0.65	240	1.58	1075
Feb	15	2.65	55	4.52	230	0.65	300	1.46	992
Mar	30	1.66	150	2.64	125	0.65	305	1.73	1175
Apr	30	1.49	125	2.72	155	0.65	310	1.56	1063
May	45	1.42	185	2.58	75	0.65	305	1.93	1313
Jun	45	1.59	240	2.99	285	0.65	570	1.71	1163
Jul	45	1.89	240	2.85	285	0.65	570	1.67	1138
Aug	45	1.51	240	2.63	255	0.65	540	1.60	1089
Sep	60	1.43	135	2.51	225	0.65	420	1.36	925
Oct	45	1.42	65	2.35	50	0.65	160	1.56	1058
Nov	30	1.44	155	2.54	155	0.65	340	1.58	1076
Dec	15	1.84	225	2.27	150	0.65	390	1.63	1109
total	435		1905		2110		4450		

* Assume PPM = 680 x Electrical Conductivity (dS/m) (Ref. 9)

** Source Ref. 8

Average electrical conductivity values of the Serw and Hadous Drain water, and the Damietta branch were calculated and used to predict the salinity levels of the El Salam Canal water (See Table G.2). The prediction indicates that after mixing the salinity varies from 900 to 1100 PPM with a maximum of 1300 PPM during May (Refer to Table G.2). As is shown in Figure G.4 the proposed mixing ratio of the flows from the drains and the Damietta for the month of May are not 1:1, suggested as design mixing ratio, but 1:3. The three times higher quantity of drainage results in the higher salinity value for May.

Limits with respect to salinity and sodium adsorption for irrigation water were set by the FAO (Refer Table G.3). Categories were establish depending on their effects on crop yield and soil physical properties. Most El Salam Canal water falls within the 500 -1750 g/m^3 category.

Table G.4.3 FAO Guidelines for Irrigation Water Quality (Ref. 10)

Irrigation Problem	No Problem	Increasing Problem	Severe Problem
Salinity of irrigation water (gm/m^3) which affects crop availability	< 500	500 - 1750	> 1750
Salinity of irrigation water (gm/m^3) which affects soil permeability	> 300	300 - 125	< 125
Adjusted sodium adsorption ratio which affects soil permeability	< 8.0	8 - 16	> 16

G.4.10 Drainage and Drainage Discharge Problems

Drainage problems can usually be expected when the infiltration rates of the soil are low. If infiltration rates of the soil are insufficient to drain the irrigation water surface ponding may occur and salt will accumulated on the soil surface. Further a shallow water table containing salts can become a continual source of salts to the root zone of crops through capillary rise of groundwater.

Soil tests conducted on the mainly sandy soils in the study area show however that infiltration rates are relatively high in most locations, and in those areas that are "moderately" and "imperfectly" drained subsurface drainage will be provided. Further the use of water efficient irrigation techniques, such as drip and sprinkler systems, are proposed. It can therefore be concluded that the proposed design of the irrigation and drainage system will unlikely lead to drainage problems and water logging.

Most of the drainage water will be discharged to Wadi El Arish, and will mostly evaporate or infiltrate into the ground during its course. The flood course of the wadi is however not well defined and a "low" flow channel is not present, water could as a consequence spread out over a relatively large area. This would result in a shallow low flowing water body that could potentially become a breeding ground for mosquitoes and an ideal habitat for the water snail that is host of the bilharzia parasite. This in turn could lead to an increase in development of diseases, such as bilharzia and malaria. Further the high nutrient contents of the drainage water could result in extensive aquatic weed growth in the Wadi, such as reeds.

Similarly impacts may apply to the other drainage areas identified if drainage discharge exceeds ground infiltration and surface ponding develops.

In the long term surface flows could develop in Wadi El Arish and drainage water would be discharged to the Mediterranean Sea via the flood course. This could result in aquatic weeds floating out to sea and ending up on the beaches of El Arish. The high nutrient load of the drainage water could also result in a stimulation of algae growth in the coastal waters.

G.4.11 Salinity Effects on Plants

The salinity or total dissolved solids (TDS) concentration of irrigation water is an important water quality consideration. An increase in salinity causes an increase in the osmotic pressure of the soil solution, resulting in a reduced availability of water for plant consumption and possible retardation of plant growth.

With adequate drainage, salt accumulation in the soil can be controlled to an extent by the rate of application of irrigation water. If the sum of applied water and rainfall is lower than evaporation and plant consumption, an accumulation of salt in the main root zone will result. Proper irrigation management should allow application of sufficient excess water, the leaching fraction, to move a portion of the salts out of the root zone, while not causing excessive increases in the groundwater table.

The El Salam Canal irrigation water with TDS concentrations between 900-1100 PPM is regarded as "high salinity water" (Australian Water Quality Guidelines, Ref. 9). The use of this water requires adequate drainage and special management to control salinity. Soil degradation could occur where a downward flux to leach salts from the soil is not properly maintained.

Plants vary in their tolerance to soil salinity and crop selection will need to take the plants salt tolerance into account. The tolerances also vary with different stages of growth, usually germinating seedlings being the most sensitive.

Crop plants which tolerate irrigation water with a salt concentration of 500 to 1500 PPM are: apple, pear, cauliflower, bell pepper, cabbage, broccoli, tomato, broad beans, field beans and sweet potato.

Crops which tolerate 1500 to 3500 PPM of salt are: oats, wheat, rye, lucerne, sudan grass, various clover varieties, millet, barley, olive, fig, pomegranate, cantaloupe, spinach, asparagus, garden beets and gherkins.

Date palm can tolerate irrigation water with a salt concentration higher than 3500 PPM.

G.4.12 Effects of Major Ions in Irrigation Water

Sodium Impact on Soil and Plants

Sodium is required in limited amounts for plant growth. However, excessive sodium in irrigation water relative to calcium and magnesium can adversely affect the soil structure and reduce permeability of the soils, forming a hard impermeable crust when dry. This affects in particular finer soils such as silts and clays.

Table G.4.4 Sodium Adsorbtion Ratios for Irrigation Water Sources

		Damietta Branch**		Serw Drain*		Hadous Drain*		El Salam Canal	
		Aug-91	Dec-92	1991	1992	1991	1992	1991	1992
Ca	mg/l	39.67	78	1.69	1.97	2.67	3.21	20.1	38.6
Mg	mg/l	3.8	24	4.33	3.98	7.03	5.41	5.2	14.1
Na	mg/l	68.19	69	10.26	9.64	18.64	16.23	41.3	40.6
SAR		14.6	9.7	5.9	5.6	8.5	7.8	11.6	7.9

* Serw and Hadous figures are yearly average concentrations

** Damietta concentrations are based on one sample per year

Source National Water Research Centre

The Sodium Adsorption Ratios (SAR) calculated from the Na, Ca and Mg concentrations measured in the drains by the Drainage Research Institute between 1991 and 1992, indicate that the SAR values vary between 5.6 and 8.5. Water quality data of the Damietta Branch upstream of the El-Salam Canal intake show that the relatively high concentrations of Ca, Mg and Na compared to the drainage water result in high SARs between 10 and 15. After mixing the irrigation water with drainage water to a ratio of one to one, the SAR will be reduced to a value between 8 and 11.

According to the Reference 9 irrigation water with SAR values in this range are considered *"high sodium water"* which could present sodium problems in soils unless there is gypsum present, but can be used on coarse textured sandy soils that have good drainage.

Irrigation water with SAR values between 10 and 15 and Electric Conductivity (ECw) values varying between 1.4 and 2.0 dS/m are expected to cause *slight to moderate reduction in the infiltration rate of the soil* according to Reference 18. Structural breakdown and dispersion of the soil is not expected since the sodium in the irrigation water does not exceed the calcium content by more than a ratio of about 3:1. Serious reduction of the infiltration rate of the soil is therefore not likely.

Some plants are sodium sensitive and can even be affected by low concentrations of exchangeable sodium, therefore crop selection and irrigation techniques should take this into account. Crops very sensitive to sodium with a SAR below 8 are citrus fruit, stone fruit and nut crops.Addition of gypsum to the soil could alleviate sodium problems.

Crops tolerant to high sodium concentrations are wheat, cotton, barley, tomatoes, beets, and grasses. Growth of these crops may however be stunted due to the poor soil structure caused by the sodium.

Chloride

Chloride is essential to the growth of plants, but in excess can be toxic to crops. It depends however on the crop and the irrigation method chosen. In general woody plant species (stone-fruit, citrus, avocados) are sensitive to low concentrations of chloride, whereas

most vegetable, grain, forage and fibre crops are less sensitive. Chlorine crop damage may result from plant uptake or folair absorption from sprinkler irrigation.
Chloride tolerance to fruit and woody crops varies from 110-960 mg/L, while foliar damage can occur at concentrations between 178 to 710 mg/L. Citrus is sensitive to a maximum of 100 mg/L when overhead sprinklers are use.

The chloride concentration in the Damietta water varied from 76 to 100 mg/L between 1991 and 1995, while the levels in the Serw and Hadous Drains range between 1.7 to 1.9.5 mg/L. From the data available it can be concluded that toxic effects on crops due to chlorine in the irrigation water are unlikely.

G.4.13 Heavy Metals in Irrigation Water

The only heavy metals that are currently monitored on a regular basis by the Drainage Research Institute in the Serw and Hadous drains are copper (Cu), iron (Fe) and manganese (Mn). Annual average values of heavy metal quantities for Serw and Hadous Drains for year 1993/1994 are shown in Table 5-1, together with the heavy metal data for the Damietta Branch.

Heavy metals were monitored in the Damietta branch during the autumn of 1995 and are reported in Ref. 11. The six (6) sample points were located between El Zarka and El Sadd on the Damietta Branch, upstream of the El Salam Canal Intake. Cadmium and lead concentrations were higher than the recommended limits for irrigation water (Ref. 9). The zinc concentration exceeded the guideline limit in one location while the copper concentration was within the guideline limit.

Table G.4.5 Quantities of Heavy metals in Damietta and Drainage Water including Allowable Limits

in mg/L	Damietta Branch[1] 1995	Serw Drain[2] 93/94	Hadous Drain[2] 93/94	Aus. Water Quality Standard for irrigation water	Max. limits allowed in drain water before mixing (decree No. 8/1983)
Iron (Fe)	NA	0.68	0.98	1.0	< 1.0
Copper (Cu)	0.033-0.086	0.18	0.08	0.2	<1.5
Zinc (Zn)	0.51-4.03	NA	0.00	1.0	<1.0
Lead (Pb)	0.44-0.93	NA	NA	0.2	no limit set
Manganese (Mn)	NA	0.01	NA	2.0	<1.5
Cadmium	0.09-0.35	NA	NA	0.01	<0.01

NA = not available
1 = Concentration of Damietta Branch Water between El Zarka and El Sadd (Ref. 11)
2 = Source Drainage Research Institute

Cadmium is toxic to both animals and plants in low concentrations. Recent research indicates that even carcinogenity may be a possibility. The high concentration may be in the Damietta water could be as a result of leaching of phosphate fertiliser. Phosphate fertiliser has an average of 0.04 g cadmium per kg P_2O_5. Cadmium is not required for metabolism but is readily taken up by plants. It can interfere with the metabolic processes