within the plants. Cadmium in nutrient solutions reduces growth of a diversity of plants at levels ranging from 0.1 mg/L to 1.0 mg/L.

Zinc is an essential element for plants and animals. High concentrations in soils may have toxic effects on plants and micro-organisms. Toxicity to plants generally starts at concentrations in nutrient solutions around 0.4 mg/L. Toxic signs for zinc include iron chlorosis, reduction in leaf size, necrosis of tips and distortion of foliage

Lead binds very effectively to most soils and is not readily transported within the plant system. The highest concentrations are usually found in the roots. Lead concentrations in irrigation water should not exceed 0.2 mg/L. High concentrations in leaves are mostly correlated to high atmospheric deposition of lead (e.g. traffic).

Manganese and iron are an essential element for plant growth. Manganese is apparently required as an enzyme activator. Clogging of irrigation pipelines is know to occur at manganese levels as low as 0.03 mg/L. Iron may cause clogging of trickle irrigation systems at concentrations as low as 0.25 mg/L. Manganese and iron concentrations in drainage water are within the guideline limit set in decree No. 8/1983.

G.4.14 Impacts on Groundwater

Quaternary Aquifer

The only major Quaternary aquifer nearest to the Study Area is found in the vicinity of El Arish. The aquifer is bottomed by Tertiary clays and limestones. The base of the aquifer dips from near sea level elevation at Lehfen to 50 m below sea level near the coast. The Quaternary deposits extend from the coastline in the north, to 10 km from the coastline in the south. The western boundary of the aquifer has not yet been definitely defined, but investigations show the absence of the aquifer 30 km to the west of El Arish. To the east the aquifer extends beyond the Egyptian border line. The thickness of the Quaternary aquifer in El Arish area ranges between 5 m at Lehfen to 70 m east of El Arish township (Ref 16).

With respect to water quality of the aquifer, the Sinai Water Resources study (1993) indicates that a low salinity zone, with salinity ranging from 2000-3000PPM, occupies the area south of the airport and to the west and southwest of El Arish town. A medium salinity zone, with salinity values ranging from 3500 and 4000 PPM, is located between El Arish town in the west, the El Arish - Bir Lehfen road in the east and the airport in the south. A high salinity zone with a salinity between 3500-6500 PPM extends along the eastern side of the El Arish - Bir Lehfen road. It is believed that the latter wells tap both the alluvial gravels and the marine Kurkar unit which is brackish water bearing. It also is possible that the wells are being contaminated by saline water from the adjacent Pre-Quaternary aquifers.

Groundwater Quality Monitoring By the Study Team

Approximately 200 wells are now existing in the El Arish area serving as water supply for irrigation and domestic use. Twenty representative wells scattered over the area were selected for water quality monitoring. The monitored wells can be subdivided in three

FIGURE G.4.5 Location of Monitored Wells

groups, the first group consisting of wells No. 1 to 6 located between the airport and El Arish city and have a salinity ranging from 1300 to 2700 PPM. The second group includes the wells No. 7 to 15 located on the eastern side of the Wadi with a salinity of 2300 to 5500 PPM, and the last group are wells 16 to 20 which include the wells on the western side of the Wadi with salinity of 1400 to 1700 PPM. See for the location of the monitored wells Figure G.4.4., monitoring results are shown in Table G.4.6a.

Table G.4.6 Water Quality of Groundwater in El Arish Area

Well No.	pH	Electric Conductivity mS/cm	Dissolved Oxygen mg/L	Temp °C	Salinity ppm	Remarks
1	7.55	4.30	9.14	24.5	2200	at pond
2	7.68	4.22	12.01	25.5	2100	at pond
3	7.32	3.08	6.53	24.4	1500	
4	7.78	2.74	10.53	24.7	1300	at pond
5	7.76	2.81	10.61	24.2	1300	at pond
6	7.40	5.32	3.04	24.3	2700	
7	7.28	5.51	4.91	27.7	2800	
8	7.26	5.83	5.68	23.3	3100	
9	7.40	6.90	4.60	26.0	3800	
10	7.23	9.90	6.39	23.7	5500	
11	7.44	6.25	4.01	25.5	3300	
12	7.48	4.55	5.61	23.0	2300	
13	7.22	5.66	4.93	23.0	2900	
14	7.26	4.84	6.08	22.8	2500	
15	7.29	5.69	4.61	23.8	3000	
16	7.67	3.14	6.05	24.8	1500	domestic
17	7.15	3.39	5.01	22.9	1700	
18	7.42	3.28	7.28	23.4	1600	at pond
19	8.71	2.91	7.38	23.1	1400	at pond
20	7.64	3.19	7.11	24.8	1600	

Note: The tests were carried out on 15 and 16 May 1996
Water was sampled either from wells or farm ponds (see remark "at pond")

Farmers in the area of the first group of monitored wells did not report any salinity problems. Crops grown in this area include melons and tomatoes. Some salinity problems were reported by farmers in the area of the second group of monitored wells. Salt sometimes accumulated on the soil surface. Olives were the predominant crop grown in this location. The third area included wells with moderate salinity levels and melons, courgettes and melons were grown in this region.

Ground Water Levels and Water Quality in the Study Area

The Upper Cretaceous Aquifer system occupies vast areas in the Sinai. The southern boundary is located tens of kilometers to the north of the southern slopes of El Tih - El Egma Plateau. The northern boundary of the aquifer runs from north of Gebel Maghara to El Halal Zone. The southern boundary extends to Aqaba - Dead Sea Rift Valley, while the western border lies near the Gebel Somar - Wadi Gharandal region.

The groundwater in the study area can be subdivided into two types, the shallow ground water and the deep groundwater. The shallow groundwater involves fissure waters in weather and fractured basement rock, groundwater in dune sand and in the Quaternary deposits in the wadi and the undulating plains. The deep groundwater occurs in the Pre Quaternary formations and, as was mentioned earlier, is mostly confined.

Table G.4.7 Groundwater and Salinity Levels at Existing Test Wells in the Study Area

Well No.-Location	Type of Aquifer	Age of Aquifer	Groundwater level (m.a.s.l.)	Groundwater Salinity (ppm)
J18 - Bir Lehfen	Quaternary		no grondwater at 45 m	-
P11	Tertiary	Eocene	51	1,440 - 5,050
P12	Tertiary	Eocene	60	
Misri 1	Tertiary (confined)	Meocene	70	10,450
63C - Libni No.3	Upper Cretaceous	Senonian	58	4,500

Source: North Sinai Groundwater Resources Study, JICA, 1992

Pre Quaternary aquifer water was dated during the JICA study, unfortunately none of the wells in the Study Area were included as the part of the study. It concluded that most of the groundwater of the Pre-Quaternary had been recharged in the geological past but that the influence of current hydrological phenomena is assumed insignificant.

Impacts of Present Groundwater Use in El Arish

Presently the abstraction of the groundwater from the aquifer system is exceeding the recharge by infiltration and wastewater. Over the past years this has caused groundwater levels in the Wadi El Arish region to drop by 1 to 3 meters due to the extraction of water for crop irrigation. Many groundwater levels which were above sealevel pre-1980 are now negative in a wide part of the area. The aquifer is now partly supported by return flows from domestic wastewater, induced flow from the adjacent areas in the west and south, by upward flows from deeper parts of the aquifer, from the older aquifers at faulting systems, and possible seawater infiltration.

The increased use of groundwater may lead to continual groundwater quality deterioration. The highest increase in salinity (1500 to >2000) has taken place in the areas to the east and west of the main road El Arish-Lehfen and to the north of the airport. This increase has eventuated over a period of 10 years (1981-1991). Ongoing development in the dune area to the west of the Wadi channel will intercept groundwater that would normally continue to the main abstraction area near El Arish and cause a further reduction of groundwater levels and an increase of salinity.

The Sinai Water Resources Study recommends that groundwater management scenarios should be developed using the groundwater model that was deployed in the study of the Quaternary aquifer in El Arish.

THE NORTH SINAI
INTEGRATED RURAL DEVELOPMENT PROJECT
(PHASE II)

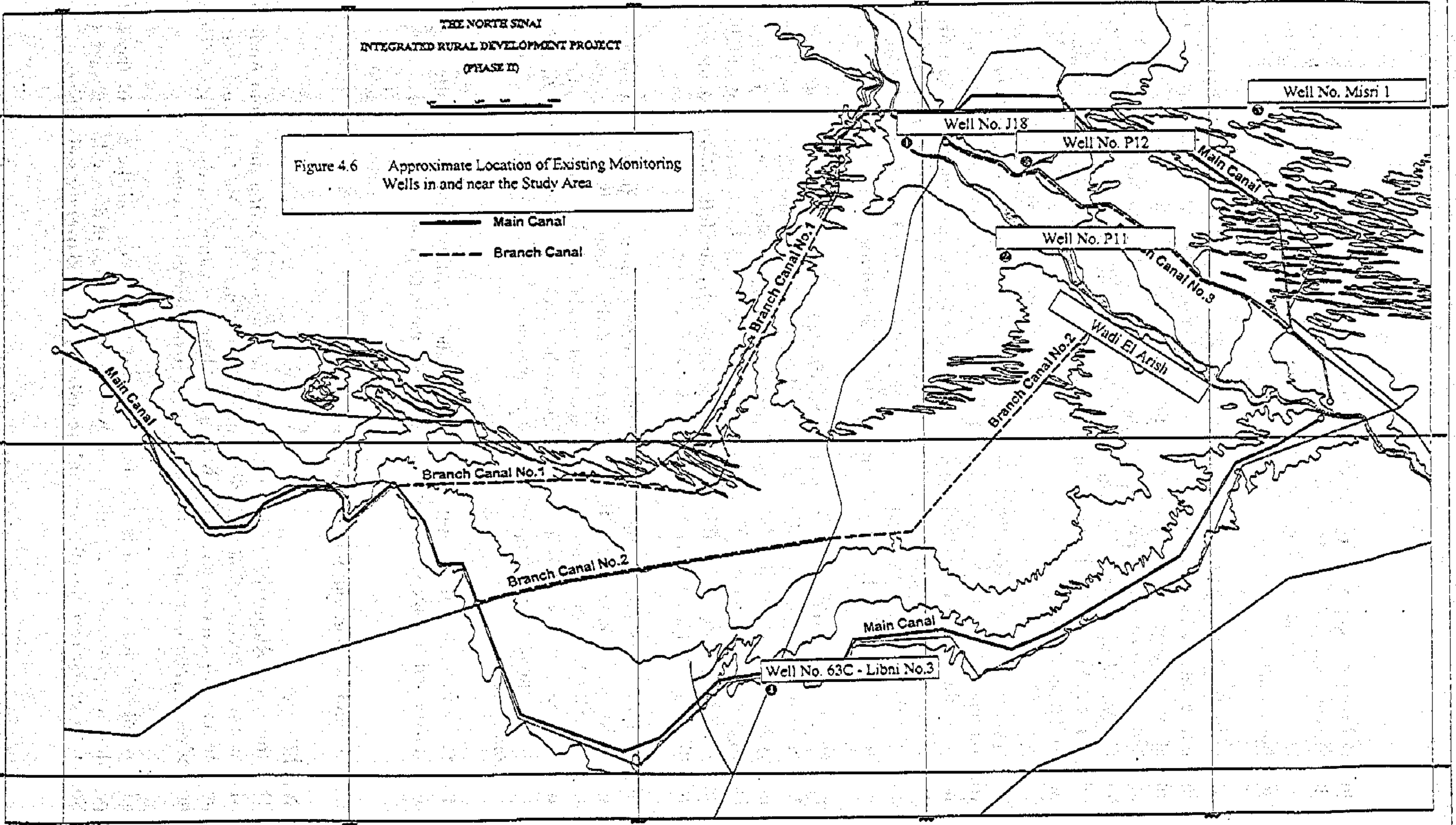


Figure 4.6 Approximate Location of Existing Monitoring Wells in and near the Study Area

Impact From Project Activities on the Aquifers
The impacts expected from the project activities on the present groundwater conditions include rising groundwater tables due to percolation losses and changes in the quality of the groundwater.

The infiltration rates of the land in the Study area are on average considered high. The final intake rate in the Wadi varies from 2 to 44 cm/hr (0.5 m/day.- 10.5 m/day). The amount of drainage water expected is difficult to estimate but 2 mm/day has been proposed as a realistic design figure. The drainage water will be discharged into the flood course of the Wadi El Arish and two separate low lying drainage areas. Since the wadi is unlined it can be assumed that most of the drainage water will initially infiltrate into the sandy soil or evaporate.

These percolation losses from the drain, as well as seepage flows from the higher elevated irrigated land, will initiate groundwater flows in northern direction and could cause an increase in the groundwater levels in particular of the Quaternary aquifer in the El Arish region. The extent of water level rise is however hard to predict without more detailed study, but there is a danger that low lying areas could be water logged due to this rise in groundwater which could affect existing vegetation and shallow wells.

The quality of the groundwater is likely to be affected by the high salt concentrations of the drainage water. The salinity levels of the drainage water are estimated to be at least around three to six times the levels of the irrigation water, i.e. about 3000 to 6,000 PPM. This high salinity water could affect the aquifers around El Arish negatively. Further increase in the already high salinity levels of the Quaternary aquifers could make the wells presently located in the aquifer unsuitable for their present use.

High salinity levels are not the only concern. Pollution from pesticides and increased nutrient loads from extensive fertiliser use can potentially contaminate the groundwater in the region. Pesticide contamination of groundwater has become a major cause of concern in many parts of the world. Not enough is known, however, of the impacts of pesticides on human and animal health, but protection of groundwater from contamination by pesticides is recommended.

It is not expected that the deep pre Quaternary aquifers will be significantly affected by the drainage and seepage water flows of the project due to their mostly confined nature.

G.4.15 Land Erosion and Land Conservation

Wind Erosion
The strong hot "Khamasin" winds, which blow mostly during spring time from April to May, can reach speeds of more than 50 km/hr. These winds create dust and sand storms, and can result in soil erosion especially in areas where vegetation is sparse and sand dunes are active. Egypt is on average affected by about 10 dust storms per year.

The extent of wind erosion is determined by the wind speed and the size of the soil particles and aggregates. Soil particles are basically transported in three different ways. (1) Soil creep; coarse particles (0.5 - 2 mm) are rolled by the wind over the soil surface.

(2) Saltation; grain movement in a series of jumps, for particles that vary in size from 0.05 to 0.5 mm. The particles are lifted in the air but are too heavy to stay in suspension and fall back to the surface. (3) Dust storm; particles smaller than about 0.05 mm in diameter which can be carried by air over large distances in the form of a dust storm.

Increasing wind erosion in sand sheet areas and desert sand dunes can be expected especially during the development phase of the project as a result of the removal of natural vegetation and disturbance of the surface crust. The surface crust which consists of fine silt particles is held together by algae and lichens. Mechanical destruction of this crust, which is even disturbed by people walking and grazing cattle, will take place on a large scale during project development. Disturbance of the soil surface will cause the underlying sand grains to be exposed to the wind and cause saltation of sand. This negative impact will continue until the project becomes operational and the soil moisture and vegetation slow down the rate of sand movement.

Active sand dunes surrounding the reclaimed areas can also threaten the crop lands and intrude into the fields during periods of high wind. Sand storms, mainly occurring during the spring period, also form a hazard for crop growth, especially during the blooming stage. Blown sand can rupture plant cells, dry out the exposed tissue, and later lead to a greater risk of damage by insects and disease. Further wind accelerates heat and water loss by the plant, and when transpiration exceeds water replenishment it can cause wilting of the plant and even cause crops to die. Strong hot winds can also adversely affect pollination, result in a premature drying of flower buds and to micro-scaring of leaves which will lead to increase evapotranspiration. Fruits can be damaged by winds greater than 6-7 m/s and can shake of fruits. Cereal crops can be flattened by winds of 12 m/s.

Erosion Due to Floods

Although the Study area receives very little precipitation, there are times when heavy rainfall occurs and flash floods develop. Land reclamation should not take place in the flood planes of the Wadi, since floods could result in severe erosion. At several locations where roads cross the wadi, box culverts have been installed in the wadi beds beneath the roadways. These have not performed satisfactorily in the past. Plugging of culverts with debris or sand, gravel and boulders has occurred and in some places the total culverts have been washed away.

G.4.16 Impacts of Aquatic Weeds

Excessive growth of aquatic weeds in irrigation and drainage canals usually causes serious problems, such as choking of waterways, hampering of flow and increasing sedimentation of the canals. Apart from reducing the hydraulic efficiency of the canals, the plants also cause considerable amounts of water to be lost by evapotranspiration.

Ideal growing conditions for aquatic weeds include slow flowing shallow water containing high nutrient loads, as well as muddy canal bottoms and sufficient sunlight, and as a result of these ideal conditions a large number of canals and drains in Egypt are heavily invested with aquatic weeds. Investation of the new irrigation and drainage canals will be almost unavoidable.

Classification of Weeds
Aquatic weeds are classified into groups according to their life forms. There are three main life forms related to the plants position with respect to the water surface:

- **Floating Plants.** These plants are not rooted in the canal bottom, and the leaves float on the water surface, or slightly emerge from the water. One of the most common floating weeds in Egypt is the water hyacinth or *Eichornia crassipes*, other types are *Lemna gibba*, and *Nymphea coerulaea*.

- **Submerged Plants.** These plants grow mostly below the water surface and may or may not be rooted in the bottom of the water course. Common submerged weeds are *Potamogeton spp.*, *Ceratophyllum demersum*, *Najas armata*.

- **Emergent plants.** Emergent plants are rooted in the soil and have their leaves above the water surface. Common emergent weeds that can be found along canal banks are *Typh domingensis*, *Phragmites austrailis*, *Ceperus alopecuroids*, *Polygonum salicifolium*, *Paspalum paspaloides* and *Echinochloa stagninum*.

The water hyacinth is the most fast spreading aquatic weed. It can increase in volume by about 700% within 50 days and a pair of plants can increase to 1200 plants in the space of four months (Ref. 12)..

Growth of the water hyacith is greately influence by levels of nutrients in the water, particular nitrogen, phosphorus and potassium. It has been estimated that upto 7 billion m^3, or one tenth of the average flow ot the Nile, was lost every year through evapotranspiraton by water hyacinth (Ref 19). This highlights the importance of weed control.

Physical Control
Manual control or hand weeding is still practiced on a large scale. The draw backs of this method are greater exposure to water borne diseases for the workers such as Bilharzia, the possibility of weed reinfestation from piles of harvested weeds on the channel banks, and the relatively high labour cost. At present the use of this method is decreasing and mechanical methods are favoured.

Mechanical control can be carried out in two ways namely, cutting or dredging. Rooted plants are usually harvested at a point near the base of the stem leaving the roots undisturbed giving the chance for regrowth of the plants in a short time period. Dredging on the other hand is much slower and more costly in operation than cutting. It also results in changes to the original cross section of the canals.

Chemical Control
Chemical control of aquatic weeds was discontinued in the early 1990's due to the negative effects this method had on the environment in particular fish. The main herbicides used for control of the weeds were Acrolein (2-propenal), 2,4-Dichlorophenoxyacetic Acid, Ametryn and Dalapon.

Biological Control

Biological control of aquatic weeds has become more popular over the years. The introduction of the grass carp (*Ctenopharyngodon idella*) in Egypt as a method of controlling aquatic plant growth started in 1976 on a experimental basis. Serious reproduction of the grass carp started in 1981 with 50,000 hatchlings. Now in 1996 500,000 hatchlings are produced in the hatchery in El Kanater and 6-8 million are produced each year in Aswan. The grass carp can eat its own body weight on weeds daily and is therefore an efficient control method, provided that the water quality is suitable for fish to live in and the stock density is sufficient.

The advantage of biological control is that it provides a low cost perpetual control with minimum detrimental side effects to the environment and it also provides extra source of edible fish. This method is however only suitable for submerged weed control since the grass carp only eats the submerged plants.

Biological control agents for water hyacinth include anthropoids and fungi, the most successful are two weevils species, *Neochetina bruchi* Hustache and *N. eichhorniae* Warner, and a moth *Sameodes albiguttalis* (Warren) (Ref 19). However optimal control has not been achieved in all situations and additional agents are being evaluated. The introduction of Manatees (*Trichechus monatus*), a water mammal that eats weed, is an other option that is being studied at the moment in Egypt.

G.4.17 Environmental Pollution by Pesticides

Pesticides include herbicides, insecticides, fungicides, rodenticides and molluscicides. These play an important role in modern agriculture. Herbicides used for weed control provide benefits such as higher food production, reduced weed control and harvesting cost, improved food quality and a reduction in irrigation costs.

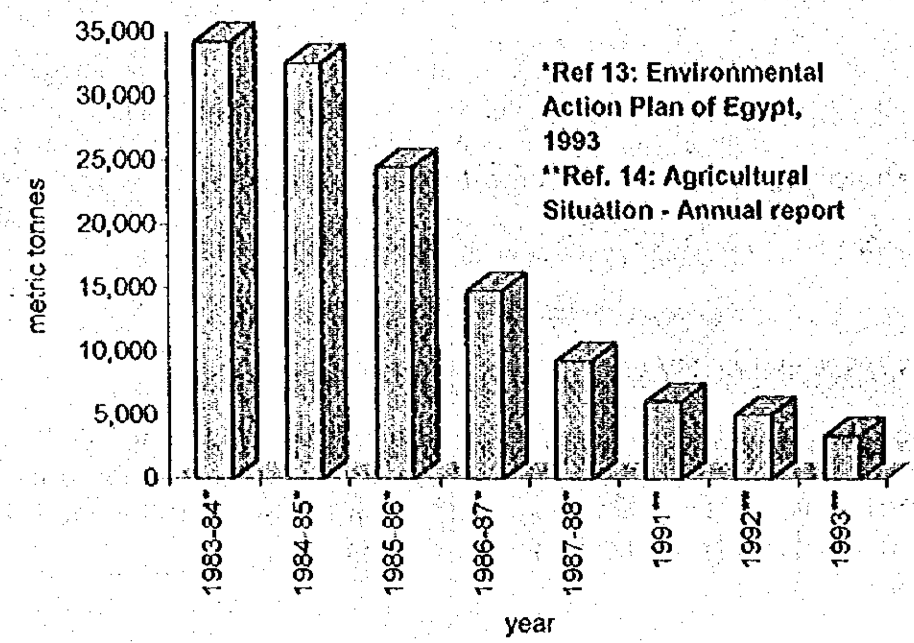
Pesticide Legislation

The Law of Agriculture Number 53 of 1966, and the ministerial decrees issued in this respect, deal with plant protection and regulation of agricultural pesticides. The Pesticide Committee of the Ministry of Agriculture is responsible for enforcing the law which includes: introduction of new pesticides, testing of pesticides, and procedures of registration. Registration deals with issues such as the recommended usage rate, treatment after misuse (poisoning), production date, warning signs and toxicological data. This information must be indicated on the label of the packaging. Manufacture, preparation, selling and importing of pesticides without a permit from the Minister of Agriculture is prohibited in Egypt.

The legislation relating to pesticides is predominately concerned with regulation of handling of pesticides during importing or trading, however little attention has been paid to the safety of workers and farmers who are in daily contact with these chemicals. One of the major constraints with respect to the labelling of pesticides is that there is no obligation to indicate the safe harvest period on the pesticides packaging, and the users are therefore not informed about the possible consequences of misuse.

Regulation of Pesticides at Governorate Level
The ministerial act No. 48 of 1977 issued by the ministry of Agriculture and the ministry of Public Health regulates the security measures for handling and application of agricultural pesticides. This act requires the establishment of a committee representative of both ministries in each Governorate, to coordinate and implement the regulations of this act. Agricultural, veterinary and medical specialists are to be appointed at Governorate and even down to village level to assist with the implementation of the regulations and to record place and time of application of sprays, kind of pesticides and the appropriate levels. The act also includes regulations for safe use of pesticides. Despite the legislation misuse of pesticide are still common and more training in the safe use of pesticide is required.

Figure G.4.7 Pesticide Consumption In Egypt



Pesticide Use in Egypt
Chlorinated hydrocarbons were predominantly used in Egypt from the 1950's until the 1970's. DDT was banned in the 1970's. Chlorinated hydrocarbon insecticides include DDT, benzene hexachloride, BHC, endrin, dieldrin, toxaphin, chlordane and lindane. These insecticides were used in large quantities due to the subsidies provided by the government.

Egypt has a relative high use of pesticides, this is mainly due to the subsidies that were provided by the Egyptian Government in the past. The use of pesticides has dropped considerable over recent years following the import limitations that took effect in 1985, and due to the phasing out of most of the subsidies in the early 1990's (see Figure G.4.6).

Toxicity of Pesticides
Acute toxicity is judged by LD_{50}, the dose causing the death of 50% of the specimen to be controlled. Factors that are important in determining the chronic effects of pesticides are

the coefficient of accumulation, the tendency to disperse in the environment, the persistence and conversion both under biotic and abiotic conditions, carcinogenity, teratogenity and other health hazards. Deaths and abnormalities resulting from different pesticides have been reported in Egypt. Workers regularly exposed to pesticides were found to be suffering from neuritis, asthma and disturbances in liver and kidney functions.

Chlorinated hydrocarbon pesticides, such as DDT and hexachlorohexane are not metabolised but accumulate in fatty tissue in the body. They are inactive when stored but at times of poor nutrition, fats are readily metabolised and chlorinated pesticides are released into the blood stream, with the possibility of toxic effects.

Pesticides can persist in the environment for many years, particularly the type consisting of chlorinated hydrocarbons. DDT can persist in the soil for up to 35 years, and although this chemical was banned in the 1970's it can still be identified in the waters of the Nile and the irrigation and drainage channels.

Results of monitoring performed in the Rosetta Branch during the period December 1990 to May 1991 show high levels of pesticides which exceed the water quality guidelines in all cases (Ref. 15). All the chlorinated hydrocarbon pesticides shown in Table G.8 have now been banned in Egypt. Although the El-Salam Canal intake is situated on the Damietta Branch, similar levels of pesticide contamination can be expected at the Damietta.

Table G.4.8 Pesticide Residues in the Rosetta B ranch (Ref. 15)

	Rosetta Branch (Delta Barrage) ng/L*	Australian Water Quality Guidelines ng/L	USEPA Water Quality Guidelines ng/L
DDT	1.3	1.0	1.0
HCH	202.5		
Endrin	9	3.0	2.3
Oxy-chlorodane	65.8	4.0	4.3
Dieldrin	36.5	2.0	
Hepta-epoxide	6.25		
Organo Chlorine	1.7		

*Monitored from Dec 1990 to May 1991, average values of four measurements done before, during and after the Winter Closure Period.

Persistence of Pesticides in Hot Climates

Most pesticides, apart from the now banned organochlorine pesticides, degrade fairly quickly on the crop and in the soil. Organophosate pesticides do not accumulate and degrade to non-toxic substances usually within a few days.

Pesticide losses in hot climates are greater than in temperate climates. This is due to the higher temperatures which aggravates pesticide loss through volitilization and through increased microbial activity, and sunlight, which degrades pesticide deposits on leaf and soil surfaces by photo chemicals action. Since the light is more intense hot climates such as in Egypt, greater losses will occur.

Mobility of Pesticides
The mobility of pesticides in the soil depends on the physical properties of the chemical, such as vapour pressure, water solubility and adsorption/desorption characteristics, but also on the field conditions. Groundwater contamination by pesticides therefore also depends on 1) soil profile; percolation rates of water are higher in sandy soils, and 2) water storage capacity of the soil; when the storage capacity is low irrigation rates are often high resulting in increased leaching of water soluble chemicals.

It is clear that the field conditions of the soils in the Study area will allow easy movement of pesticide residues due to the sandy nature, the low organic matter content and the relative low water storage capacity. Indiscriminate pesticide use could therefore result in contamination of the aquifers in the El Arish region.

Impacts of Pesticides
Good agricultural practices do not usually result in exposure to hazardous amounts of pesticide residues. Environmental contamination and health hazards due to pesticides are often created due to irresponsible negligence of users, such as not following label recommendations, unawareness of consequences of the effects of misuse of these chemicals on health and environment, not allowing for safe harvest intervals between pesticide applications and crop harvest, inadequate storage of chemicals, unprotected use and handling and indiscriminate disposal of or cleaning empty chemical containers in irrigation canals.

When the safe harvest time, which is the minimum time between application and crop harvest is often not respected high residues could still be present on the crop which could affect human health. Although only in extreme cases exposure to residues in food appear to be harmful, if minute quantities are consumed, there seems to be no direct danger to human health (see Table 4.9 for type of pesticides used in Egypt).

G.4.18 Eutrophication of Irrigation and Drainage Water

Overdosing of fertiliser on agricultural land can result in high levels of nutrients in the drainage water causing eutrophication. High nutrient concentrations will result in stimulation of aquatic weed and algal growth.

Three types of fertilizers are mainly used, nitrogen, phosphate and potasium. Nitrate, which is produced through nitrification, is readily leached from soils. While the phosphate fertilizers are easily absorbed by the soil and therefore the concentration in drainage water is usually not as high as the nitrate concentration. In fresh water the algal blooms are mainly the result from increased phosphate concentrations, while nitrate concentration will influence the kinds of algae that grow, some of which cause taints in drinking water or or toxic to animals.

The types of weeds that can be expected to be stimulated by the nutrients are reeds, grasses and submerged pondweeds in the irrigation canals. In the earthen irrigation canals, where flow will be low, pondweeds, hornwort and grasses can be expected. In the lined canals the growth of mainly filamentous algae and duck weeds will be stimulated. Water hyacinths will be the most dominant weed in the drainage canals.

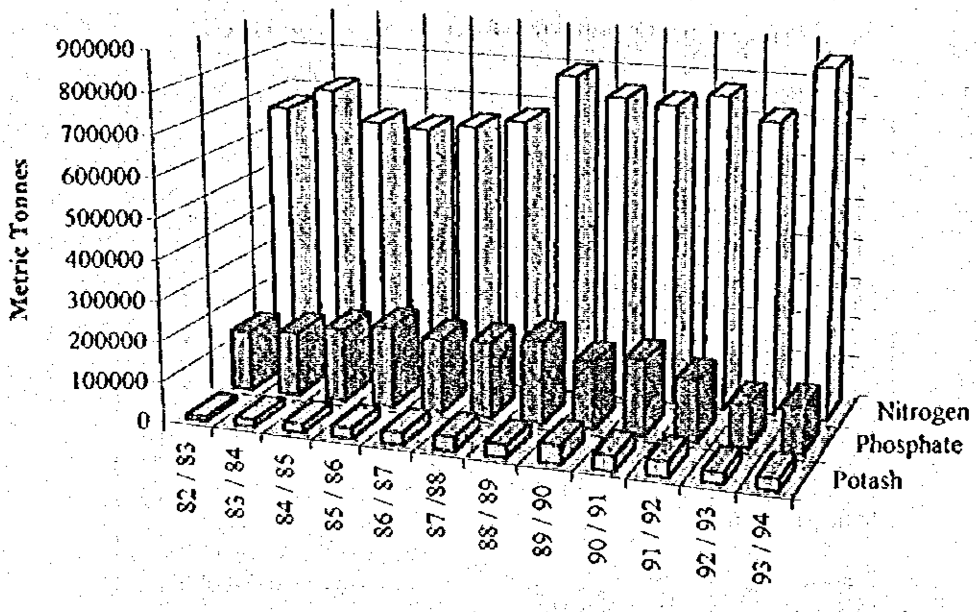
Table G.4.9 Pesticides Used in Egypt and Their Toxicity

Pesticide	Trade name	Type	Oral L_{50} mg/kg	Toxicological Remarks	WHO hazard rating
Bifenox	Modown	H	5000		1
Bromoxynil	Brominal	H	190		4
Atrazine	Gesaprim	H	1869	high environmal persistence	1
Prometryne	Gesagard	H	5232		
	Mangober	F	-	carcinogenic metabolite	
Cu-oxychloride		F	-	gastrointestinal inflamm.	
Sulpur		F	-	relatively toxic	
Benomyl	Benlate	F	>10.000		1
	Robigan	F	5762		
Diazinon	Basudin	I	76		3
Dimethoate		I	219-325	very toxic orally	4
Malathion	Celthion	I	885		2
Profenofos	Selecron	I	358		
Pirimiphos	Actellic	I	2050	persistent in soil	2
Carbosulfan	Marshal	I	250	cholinesterase effects	
Tamaron 60		I	30	extremely toxic	
Mancozeb	Dithane M45	F	5000	carcinogenic metabolite	1
Ametryne	Gesapax	H	1750		
Metribuzin	Sencor	H	1100		
Linuron	Linuron	H	1500	moderate oral toxicity	1
Diuron	Karmex	H	437	moderate oral toxiicity	1
Fluometuron	Cotran	H	1840		
Trifluralin	Treflan	H	10,000	moderately oral toxicity	1
Dinitramine	Cobex	H	3000		
Alachlor	Lasso	H	1000		
Diphenamid	Enide	H	1000		
Paraquat	Gramoxone	H	150	extremely toxic	4
Diquat	Reglone	H	230	high oral toxicity	4
EPTC	Eptam	H	1625		
DCPA	Dacthal	H	>3000		
2,4 D	2,4 DB	H	370	mod. to very orally toxic	2
Dalapn	Dowpon	H	970	moderately orally toxic	1
Glyphosate	Roundup	H	470	moderately orally toxic	1
Molinate	Ordram	H	720	sperma toxic to animals	
Dichlorprop	Basagran	H	800	mod. oral and skin toxicity	2
Oxadizon	Ronstar	H	2300		
Norflurazon	Zorial	H	8000		
Oxyflurofen	Goal	H	5000		
Pendimenthalin	Stomp	H	1050	moderate oral toxicity	2
Fluazifop-butyl	Fusilade	H	3000		1
Sethoxydin	Nabu	H	2670		
Haloxyfob	Gallant	H	2397		
Methomyl	Lannate	H	17	extremely toxic orally	5

World Health Organisation Hazard Rating
1 = unlikely to present an acute hazard in normal use
2 = slightly hazardous
3 = moderately hazardous
4 = moderately toxic
5 = highly toxic

Pesticide Type: H = herbicide, F = fungicide, I = insecticide,

Figure G.4.8 Fertilizer Consumption In Egypt between 1982 - 1994
(FAO Fertilizer Year Book 1994)



G.4.19 Socio Economic Impacts

The project will also have a positive impact on the industries related to agriculture, such as the fruit and vegetable processing industries. Improved farming practices using modern irrigation techniques will result in a higher productivity and better quality products

G.4.20 Settlement Issues

Settlement Planning

The study by GARPAD (Ref 17) mentioned that settlers suitable for irrigation projects in the North Sinai should preferable come from previous reclaimed areas because they have acquired the skills and valuable agricultural experience required for unfamiliar conditions. Also should be included the adult children of settlers in existing schemes since they are also familiar with the challenges of developing farms in new areas.

With respect to geographical origin, opinions seem to vary, on the one hand it is believed that selecting settlers in groups from the same place of origin is relatively unimportant since it reduces the advantages to be gained from introduction of a mixed range of experience and ideas (Ref 17). While on the other hand difficulties have arisen from using mixed groups of settlers, due the uncohesive social groupings.

Socio-Economic Categories of Settlers

Three categories of settlers were selected for this project (land allocation shown in brackets):

- Small scale and graduate farmers (25%; this includes 5% for Bedouins)
- Small scale investors (15%)
- Large scale investors (60%)

Selection Procedure
Three types of committees are involved in the selection of the settlers. Policy decisions are made in a committee existing of ministers and governors. These include for instance the Minister of Public Works and Water Resources, Transport, of Agriculture, Planning and the governors of Port Said, Isamilia and North Sinai.

The committee of high level official includes representatives of the Governorates, the various ministries and the NSDO. Their task is to develop the selection criteria and guidelines.

The NSDO selection committee is responsible for the evaluation of the settlers. This committee consists of 12 to 14 NSDO officials such as civil engineers, lawyers and accountant who scrutinize the settler applications and select the settlers.

Selection Criteria
General selection criteria for all settlers that are presently used for the reclamation of the Tina Plains include: Egyptian citizenship, mental stability, good health and no past criminal record.

Specific criteria and requirement presently used by NSDO for the selection of settlers in the Tina Plan Zone are shown in Table G.4.10. These selection criteria are only indicative and may change for the Zones to be reclaimed later. For the next phase a fourth category will be introduced which includes ex-army personnel, ex-employees from the governmental sector and retired people.

The final selection of the investors depends mostly on the proposal of the investor. This includes his proposal of financing and his cropping plan. Small scale farmers will be selected via a ballot system after evaluation of their application.

The local population in the reclaimed area which is presently cultivating land, without prove of landownership can obtain the land for 50% of the set price. This would apply to a majority of the Bedouins in the Study Area.

Resettlement
The project is located far from main urban centres and it may take some time for the new population to settle. For the success of this project it is therefore most important that the new settlements provide good public facilities, such as a reliable water supply, public transport, schools, hospital shops and telecommunication to attract new settlers.

Table G.4.10 Requirements and Selection Criteria for the Three Categories of Settlers in Tina Plains

Small Scale Farmers **Graduate Farmers**	**Small Investors**	**Large Investors**
Fixed land price LE 3,000/feddan	Fixed land price LE 10,000/feddan	Min. land price LE 10,000/feddan
No advanced payment	Advanced payment min. 10%	Advanced payment min. 10%
Pay back 15 yearly payments, start after 4th year water is available Four year probation period	Pay back 10 yearly payment, start after 4th year water is available Four year probation period	Pay back 10 yearly payment, start after 4th year water is available Four year probation period
Final Selection by ballot system	Final Selection depends on proposal of investor (finance and crop plan)	Final Selection depends on proposal of investor (finance and crop plan)
On-farm works by installed and financed by NSDO. Payback over 15 years	On-farm works installed by NSDO at LE 1500 feddan, financed by investor	On-farm works installed and financed by investor
Max. area of land ownership shall comply conditions of Law 143/1981	Max. area of land ownership shall comply conditions of Law 143/1981	Max. area of land ownership shall comply conditions of Law 143/1981
Maximum area allowed 10 feddan	Maximum area allowed 500 feddan	Minimum area allowed 500 feddan
Land for housing will be provide in the village, land cost LE 1/m^2 (compulsory)	Land is available for housing at LE 10/m2 (Not compulsory)	Investor is responsible for his own house
One intake will be provided per 100 feddan	One intake will be provided per 100 feddan	One intake will be provided per 100 feddan

Technical and Professional Services

Attracting government officers, technical staff, and other professionals to new farming communities has in some case been difficult in the past. This has resulted in a failure to staff important services such as schools, health facilities, agricultural extension and banks, with as consequence a low level of amenities and services, particular in small settlements. The physical and social isolation, the shortage of shops and the inadequate social services, particular for education and health care have discouraged especially graduates and their families from establishing a permanent base in newly settled areas in the past (Ref 17).

It might therefore be necessary for the success of the project to provide incentives as part of the settlement strategy to attract technical and professional staff to the project area in the form of special salary bonuses for pioneers.

Ancillary Services
It is also important that settlement plans include for the establishment of commercial enterprises and ancillary services, such as traders and craftsmen, such as blacksmiths, carpenters, mechanics, etc. Allowance should be made for commercial space, as well as housing to be occupied by traders and craftsmen.

Settler Training
The NSDO has a special department for training of settlers, the training of settlers will include topics such as water management and irrigation system maintenance, farm management and accounting, and new farming systems for reclaimed lands.

4.21 Diseases and Public Health

The introduction of Nile water into this region could pose a serious risk of introducing new diseases in the North Sinai. Major water related infectious diseases in Egypt are: Schistosomiasis, Hepatitis, Encephalitis, Filariasis, Typhoid and Malaria.

The number of deaths caused by various water borne diseases in Egypt totaled 19,395 deaths in 1979, while in 1987 the number of deaths had risen to 45,458 in 1987 according to the World Health Organisation.

Schistosomiasis (Bilharzia)
Two species of human schistosomisasis are endemic in Egypt: *Schistosoma mansoni* and the *Schistosoma heamatobium.* People that are infected with schistosomisasis will excrete schistosome eggs in their faeces or urine. The eggs will hatch into miracidia or tiny swimming organisms in water. These organisms in turn will infect snails. The *S. mansoni* mainly infects snails of the genus *Biomphalaria* while the *S. haematobium* mainly infects snails of the genus *Bulinus.*

The individual snails species prefer different habitats but, very roughly speaking, *Bulinus* species prefer still or very slowly moving water. *Biomphalaria* can live in gently flowing water and tend to occur in streams and irrigation systems.

The snail will after infection shed many cercariae, a swimming form of the schistosome, which will infect their next host, the human, through the skin when it is immersed in water or sometimes when a person is drinking infected water. Young people are most at risk, due to the high frequency of their contact with snail infected water. Symptoms arise, not from the worms, but from the eggs which fail to escape in the urine or faeces. These symptoms increase gradually and severity is related to the worm load. Long term effects include serious damage to the kidneys, liver and urinary tract, while a common symptom of *S. haematobium* Schistosomiasis is the presence of blood in the urine.

In Egypt, *Biomphalaria* breeding is highest in March. The prevalence rate of Schistosomiasis heamatobium and Schistosomiasis mansoni in the different districts of North Sinai Governorate is far below the prevalence at the national level.

Aquatic plants provide a habitat for the snails that spread Bilharzia. The vegetation provides both shelter and food to the snails. The snails prefer submerged pond weed (*Potamogeton crispus*), followed by water hyacinth and *Panicum repens*.

Malaria and Filariasis

The most common and serious malarial infections are caused by two species of protozal parasite *Plamodium Falcipaum* and *P. vivax* resulting in acute bouts of fever which recur at intervals. Malaria is transmitted from person to person by mosquitoes of the *Anopheles* genus. Seven species were recorded in the North Sinai Governorate while ten species of the *Culex* genus were found in this region. The *Culex* transmits *Wucherieria bancrofti*, the parasite which causes filariasis, and rift valley fever (in cattle and sheep).

Filariasis is caused by a worm which develops in the lymphatic system and releases vast numbers of tiny larvae into the blood stream. The worms may obstruct the lymph ducts and cause swelling of the limbs.

Anopheline mosquitoes have been recorded in four districts in the North Sinai Governorate: El Sheikh Zuwayd, Bir Al Ebd, Rafah and El Hasana. Culicine mosquitoes are present throughout the governorate. At present the North Sinai Governorate is presently free from malaria and Filariasis is not endemic.

Leishmaniasis

Sandflies are responsible for the transmission of leishmaniasis caused by a species of flagellate protozoon, *Leishmania*. Sandflies breed in damp organic debris, caves, animal burrows and refuse dumps. Visceral leishmaniasis was first discovered in Egypt in 1985 near Alexandria (El Agamy). Cases of the cutaneous leismaniasis have been reported in the North Sinai Governorate (Ref. 7).

Checking the new settlers for these infectious diseases before they move into the Study Area will be necessary to control the spread of the diseases. Other methods to reduce the snail population involve engineering means.

G.4.22 Water Supply and Sanitation

The present methods used for human waste disposal are very primitive. In the villages pit latrines and septic tanks are mostly in use. Bedouins dispose of their excreta in the open desert.

Introducing a water supply system in the new settlements in the Study Area could create health problems related to wastewater disposal and should be accompanied by the construction of new sewer systems and wastewater treatment plants

It is expected that 0.3 to 2 kg of refuse will be created per person per day. Piles of refuse left uncovered encourage fly and mosquito breeding and transmittion of diseases.

G.4.23 Power Demand Impacts

The energy allowance for the El Salam Project used by the Ministry of Electricity is 0.75 Megawatt per feddan. The total power requirement for the project (400,000 feddans) is therefore 300 Megawatts. The construction of additional high tension power lines from the power station in Abu Sultan has been started to meet the increasing power demand.

G.4.24 Impacts of Effluent Reuse

The reuse of wastewater effluent is proposed for the irrigation is of wind breaks and green belts surrounding the settlements. Due to the scarcity of water as a resource in the reclaimed areas reuse is recommended. Health hazards could however result from reuse of wastewater effluent and treatment will need to be adequate.

Human exposure will need to be avoided, and access should be restricted in areas irrigated. Irrigation techniques such as sprinkler irrigation could result in drifts of effluent during application under windy conditions. Drip irrigation reduces this risk of exposure to workers, however the suspended solids content in the effluent needs to be sufficiently low to prevent blockage of emitters.

G.5 ANALYSIS OF ALTERNATIVES

G.5.1 Alternative Water Conveyance Routes

Description of the Routes
Three alternative water conveyance routes were developed Route A, B and C. The proposed water conveyance system consists of a combination of open channel, box culvert and pressured pipeline sections, depending on the location.

Route A is the shortest route and runs through a heavy undulated sand dune area in order to minimise the canal length. The total length is approximately 41 km. It consists mainly of box culvert and pipeline sections to prevent sedimentation of the conveyance system by shifting sand dunes.

Route B is planned to avoid most of the sand dune area as much as possible, and is therefore longer. By avoiding the unstable sand dune area, less excavation work is necessary during the construction of the canal. This alternative also involves a reduced length of the pipeline section. The total length is approximately 45 km.

Route C starts at the end of the box culvert section of Route B and follows a considerable flat area at the west side of the Study Area. In this alternative it is possible to construct a longer open channel section and thereby reducing the pipe line section even further.

The combination of Route B-C2 was selected as the most economic route, after evaluation of construction, operation and maintenance cost. This alternative has a total length of 42.4 km.

Three pipe materials were considered: steel pipes, prestressed concrete cylinder pipes, fibre reinforced plastic mortar pipes and ductile cast iron pipes. Steel pipes were considered the most cost effective pipe material. The steel pipes will be constructed on site in the vicinity of the construction area.

Environmental Evaluation of Alternative Routes

Impact on Land Use
The pipe line conveyance routes pass through an area that is sparsely populated. The area that is mostly utilised is the area south of the main road from Qantara to El Arish which is easily accessible from this road, and is used by some local Bedouin for grazing their goat herds and camels, and some small plots are developed for cultivation of vegetables near wells. These irrigated plots are mostly located south of Bir El Abd. Route B passes through this region while Routes A and C avoid this most of area.

Impact of Erosion
Land erosion is expected during construction especially in the sand dune areas. It will therefore affect mostly Route A, which passes through this areas. Route A will involve more excavation work during the construction period then the alternatives B and C, and

subsequently result in a greater disturbance of the natural landscape. It could potentially result in greater land erosion. This impact is however of temporary nature.

Impact on Vegetation and Wildlife
The excavation work for Route A will be more extensive and therefore will have a greater impact on the local vegetation.

Route A will possible have less impact on the movements of native fauna in the area then Alternative B and C . Since this alternative mostly consists of box culvert and pipe line sections it does not restrict animal movements in the same way open channels create barriers for animals. However no significant migration of animals are known to take place in this region and the impacts are therefore considered negligible.

Impact on Historic Sites
A historic site is located to the west of the new proposed location of Pumping Station No. 7. It has been identified as a ruin of a fortress from the Roman era, 332 BC - 324 AD. The ruin is situated in a valley and has not been excavated. The proposed route C passes through this valley and excavation of the canal will result in the destruction of this historic site.

Environmental Evaluation of Alternatives			
Impact	**Route A**	**Route B**	**Route B-C**
Land Use	-1	-3	-2
Vegetation	-2	-1	-1
Wild life	-1	-1	-1
Erosion	-2	-1	-1
Historic Sites	0	0	-3
Cost	-3	-3	-2
	-9	-9	-10

+/- = positive/negative impact
0 = no impact
1 = some impact
2 = considerable impact
3 = serious impact

Evaluation
Alternative B-C is the preferred and most economic option, it will however have a serious impact on the historic site located on Route C. The environmental evaluation shows that Route B-C would have been the "least impact" alternative if the historic site can be save from destruction. Since Route B-C is the preferred option it is recommended that alternative trajectories of the canal in the vicinity of the ruins are further investigated during the detailed design phase to reduce the impact.

G.5.2 Alternative Cropping Patterns to Reduce Water Shortage

Crops patterns were developed to provide the highest returns using the most suitable crops for the conditions in the Study Area. Due to the high salinity of the irrigation water crops are selected that are relatively salt tolerant. In total twenty three crops were selected which include cereals, fodder, oil crops, pulse crops, vegetables, medical plants, and fruits.

Cropping patterns are different for each settlement category, such as small farmer, graduate farmer, small investor, and large investor. Further they take into account the available irrigation water, which is set at 30 m^3/gross feddan/day. Cropping patterns are also designed to achieve a high productivity. Presently short falls in water supply are forecast in the summer. These shortfalls are predominately caused by unofficial drainage water re-use.

A reduction of water demand in the summer, can be achieved by a reduction of the area allocated for the use of summer crops. Note that crops with high water requirements such as cotton and rice are not included in the proposed cropping patterns.

Further demand savings can be achieved by leaching fields outside the summer period, provided salinity levels do not increase above crop tolerance levels.

Increasing irrigation efficiency could be an other alternative to reduce water demand, but as is mentioned below, the irrigation methods proposed are those techniques that already have a relative low water use and high irrigation efficiency and it could be difficult to achieve further water savings.

Using additonal sources of irrigation water to prevent water shortage are presently still under investigation.

G.5.3 Alternative Irrigation Methods

Irrigation techniques include systems such as flood irrigation, sprinkler irrigation and drip irrigation. Sprinkler systems include hand-moved sprinklers, hosepulled sprinklers, fixed sprinklers, side roll sprinklers, centre pivot sprinklers and linear moved sprinklers.

Flood irrigation will result in a high water use, low irrigation efficiency and could result in wide-spread water logging of the soil.

Sprinkler irrigation will apply water uniformly over the land and if well designed should not result in any overland runoff. Evaporation losses are higher than drip irrigation systems but lower than flood irrigation. Sprinkler systems could cause leaf burn to certain crops, when salts concentrate on the leaves.

Drip irrigation provides localised irrigation at very low application rates. It is specially suitable for perennial crops such as fruits trees. Filtration of irrigation water will be necessary to prevent clogging of the emitters. Salt could built up in isolated pockets where water does not infiltrate sufficiently to accomplish leaching. It is therefore important that soil is leached periodically to avoid salt built up, especially during crop rotation.

Due to the high infiltration rates of the sandy soils in the Project Area sprinkler and drip irrigation systems are considered most suitable and water efficient.

G.5.4 "No Action" Alternative

The "No Action" alternative, or sometimes called "No development" alternative, will not take advantage of the potential of the region to become an area of agricultural importance and will add no economic value to the region. It would further not provide an redistribution of population from densely to less densely inhabited rural areas, and opportunities for the unemployed and land less farmers.

A "No Action" alternative would not result in the impacts on the environment as would have been the case when the El Sir and El Kawareer Zone was developed. However land reclamation and development using carefully designed environmental mitigation plans, together with regular monitoring of environmental parameters should reduce the significant impacts to a acceptable level.

G.6 MANAGEMENT PLAN TO MITIGATE NEGATIVE IMPACTS

Mitigation measures to reduce the significant environmental impacts to an acceptable level are given below. In some cases however implementation of mitigation measures is not possible and compensatory measures are proposed.

6.1 Compensation For Loss of Natural Habitat

Most of the 135,000 feddan to be reclaimed in the North Sinai as part of this project can be considered as arid wilderness. Even though some parts of the area have been influenced by the local Bedouin tribes through grazing and cropping, the majority of the land is still relatively undisturbed. Further it can be expected that the infrastructural development of the region and the high increase in inhabitants will lead to an increased pressure on the adjacent wildlands.

To prevent irreversible elimination of the unique flora and fauna of the North Sinai, a conservation area or areas could be established. This inland reserve, similar to the protected areas of Lake Bardewill and Zaranik, can provide protection to the local vegetation and wildlife of the North Sinai.

It is therefore recommended that a survey is undertaken to identify an area or areas of a appropriate size which can be added to the existing system of natural protectorates.

6.2 Action Plan for Conservation of North Sinai Archaeological Sites

An action plan has been developed to safeguard the archaeological sites in the North Sinai. This was prompted by the digging of the El-Salam Canal and the development of the North Sinai for agricultural purposes. It was believed that urbanisation of the area could destroy the unique monuments present in the Sinai. The plan was developed by the Supreme Council of Antiquities (former Egyptian Antiquities Organisation) in coordination with the Cabinet Information Decision Support Center and the Regional Information Technology and Software Centre. Work started in 1992, with international collaboration.

The action plan allows for minor sites that are destined to be destroyed by the canal to be fully excavated and documented before the site is handed over for construction. Major sites will be secured and rescued. The major sites will become archaeological national parks and serve as tourist attractions.

The archaeological surveying and excavation work will proceed in four successive phases which coincide with the phases of development of the irrigation project. The four phases are:

- Eastern Quantara -Pelusium
- Pelusium - Bir El Abd
- Bir El Abd - El Arish
- Southern El Arish

The North Sinai Development Organisation has presently an agreement with the Supreme Council of Antiquities (SCA) to provide financial support for the investigation and restoration of major archaeological sites along the El Salam Canal for a total length of 60 km. A similar arrangement is recommended for the development the El Sir and Kawareer Zone

G.6.3 Water Management

Real Time Monitoring

The MPWWR has implemented a telemetry system to manage the operation of the Nile River Irrigation System in Egypt. It has as goals to assist in the improvement of water distribution and elimination of wasteful water practices, incorporate drainage water reuse, to protect the quality of the Nile flows, and to develop groundwater sources.

The telemetry system will provide real time data on water levels, flows and salinity. It includes the capability of remote control of major gates and regulators.

It is recommended that this telemetry system is extended to the irrigation systems of the newly reclaimed areas east of the Suez Canal. It is important that water quality and water quantities of the irrigation water and reused drainage water are monitored, since variation in salinity of the reused drainage water will affect the mixing ratio used. (Refer also to Monitoring Plan Chapter G.7)

The following facilities are proposed to be included in the telemetry system:

Damietta Intake	Discharge and Water Quality
Sirw Drain	Water Quality
Main Canal - Sirw Drain downstream of Confluence	Quality
No. 1 & 2 Pumping Station	Discharge and Pump Condition
No. 3 Pumping Station	Water Quality, Discharge, Pump Condition
Main Canal-Hadous Drain downstream of Confluence	Water Quality
Main Canal Bakar Syphon	Water Level
No. 4, 5, 6, 7, Pumping Station	Discharge, Pump condition
Cross Regulators	Water Level (up and downstream of regulator)
Spillway at 93 km	Water Level

Water Management and the SIWARE Model

A simulation model (SIWARE) has been developed to predict drainage water quality and salinity for various water management or cropping pattern options. This model is used for the development of future irrigation water management strategies. It includes physical, hydrological, crop physiological and agronomic processes.

This simulation model is therefore an important tool for the water management of the newly reclaimed areas East of the Suez Canal and allows new management strategies to be tested prior to implementation. This is especially important when changes occur in water quality parameters, cropping patterns or soil conditions.

G.6.4 Management of Irrigation and Drainage

Salinity can be controlled by providing adequate drainage, flushing accumulated salts by leaching, smoothing uneven fields and by appropriate timing of the irrigations .

Subsurface Drainage

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 this water. Soil tests conducted in the study area show however that infiltration rates are high for most soils. Furthermore most of the areas with soils classified in drainage class 3 and 2 ("moderately well" and "imperfectly" drained soils) will be provided with subsurface drainage. This should ensure an effective removal of the drainage water and should further avoid the development of a high groundwater table in the crop root zone and it is therefore unlikely that drainage related salinity problems will occur, as long as the downward flux of water to leach the salts from the soil is maintained.

Drainage Water Discharge

Drainage water will be discharged to the Wadi El Arish and two designated drainage areas. If low or still standing shallow surface water bodies develop in Wadi El Arish due to this discharged drainage water, formation of a "base" flow channel may be necessary to provide a controlled flow path for the drainage water, to prevent the development of on environment that is favourable to mosquitoes, water snails and aquatic weeds.

Leaching

Leaching is a key factor in controlling soluble salts brought in by irrigation water. To prevent salts building up in the soil, removal of salts by leaching must equal or exceed the salt additions from the applied water. The amount of water required for leaching depends upon many factors such as amount of salts initially present in the soil and groundwater, type of salts, quality of leaching water, soil permeability, efficiency of drainage system, depth to be leached, and type of leaching. The leachings should be timed in such away that salt tolerance levels of the crops are not exceeded so yields will not be effected. Leaching requirements can be predicted using specially developed formulas (Ref. 18), but the actual amounts of leaching taking place can only be estimated. Soil and crop monitoring should therefore be used to determine the need for leaching (Refer also to Chapter G.7 Monitoring Plan).

Land smoothing

Salinity control is often difficult on uneven fields, since salts will accumulate in the high spots and uniform water distribution can not be established. High areas will have little penetration and leaching while the low-lying areas may become waterlogged, and this can affect seed germination due to high local salinity and shortage of water. Land smoothing should be a regular practice after changing crops, to ensure uniform water distribution.

Timing of irrigations
Timing of irrigations is important since it will reduce water stress between irrigations, and thereby prevents excessive root zone depletion caused by too long an interval between irrigations. This is especially important when using high salinity irrigation water.

G.6.5 Reduction of Heavy Metals Residues in Surface Waters

To control pollution of drainage and irrigation canals by pollutants such as heavy metals that are being discharged into these waters, appropriate treatment of the industrial and other wastes will be required before disposal. It is therefore recommended that Law Number 48 is more strictly enforced to improve water quality in the Nile and its tributaries.

G.6.6 Erosion Control

Conservation methods of erosion control due to wind include planting of ground cover vegetation, installation of palisades and placement of windbreaks or shelter belts between the crop fields.

Wind Breaks
Wind breaks can consist of shelter belts of trees or on a smaller scale can consist of stone walls, slat and brush fences and cloth screens. A shelter belt is designed so that it rises sharply on the windward side and provide both a barrier and a filter to wind movement. Wind breaks will reduce windspeeds, and trap airborne sand behind the barrier.This will cause the formation of ridges behind which plant growth is possible

A complete belt can consist of two tree rows and up to three shrub rows, one of which is placed on the wind ward side. The density of the belt should not be so great as to form an impermeable barrier nor so sparse that the belt is transparent. Widths of shelter belts can vary from 3 to 10 meters depending on the number of tree and shrub rows. These widths mean that belts can occupy about 3% of the land area they are protecting. The best protection is provided by shelter belts that are placed at right angles to the most dominate erosive wind direction. Gaps in the windbreak should be avoided as funneling effects will increase wind speeds. Roads and canals should therefore not cross a wind barrier at right angles. The ideal spacing of wind breaks varies from 5 to 25 times the height of the barrier. The plant species selected for shelter belts should be rapid growing, tolerant of dry conditions, wind and light. Acacia, casuarina or eucalyptus species are presently mostly used as shelter belt trees. The side effects of shelter belts are lower soil temperature near wind breaks resulting in a decreased evapotransporation, but also in a greater risk of weeds and pests developing. Irrigation of shelter belts using drip feed systems will be necessary.

Palisades
To prevent crop fields and settlements from moving sand dunes the creation of an artificial dune on the upwind side of the area to be protected can be used as an obstacle

initiating sand accumulation. This requires building a palisade or wall with 50% porosity at right angles to the main wind direction about 200 m upwind of the area to be protected. The palisade will eventually be buried in the sand and it can than be lifted or another palisade can be put on top of the first. Materials can consist of cheap locally availabale materials such as branches, palm branches, rice straw, etc.

Physical Covering

Temporary measures to fix sand sheets or stabilise sand dunes can include covering the sand for long enough to enable growth of vegetation. Materials such as branches, palm fronds, mats, etc. could be used. The lifespan of these materials is not long, but they can be used to prove immediate protection around villages, roads and canals until vegetation is established.

Crop and Vegetation Management

Generally row crops are the least effective in erosion protection due to the high percentage of bare soil between the crops, especially in the early stages of crop growth. Ground covers can be grown between crops however the covers will compete for the available moisture with the main crop and may affect their growth.

Ground covers are usually grown under tree crops to protect the bare soil from erosion. These ground covers have also as advantage to retain nutrients in the soil which would otherwise be removed by leaching. The changing condition during the growth of the tree crops, can however result in the cover plants to die off. Most covers give no income to the farmers which restricts their use on small farms.

Strip cropping or multicropping, row crops and protective effective crops can be grown in alternating strips aligned on the contour or perpendicular to the wind to reduce erosion, because the erosion is then largely limited to the row-crop strips and the soil removed from these is trapped in the next strip downwind which is generally planted with a leguminous or grass crop. Strip cropping also prevent erosion from irrigation water runoff and is especially suited for well drained soils because the reduction in runoff velocity, combined with a low infiltration rate can result in water logging. Strip cropping is not suitable for highly mechanised agricultural systems. Other problems associated with strip cropping are insect infestation and a greater risk of weeds.

Geotextiles

Various types of netting woven from natural of artificial fibres are now manufactured commercially for use in erosion control. They are usually supplied in rolls, unrolled over the hill slope from the top and anchored with large pins. They are designed to give temporary stability until such time as the vegetation cover grows. Their success depends on the area of contact between the soil and the net and on a firm attachment of the mesh to the ground. Netting is also made for use as windbreaks.

Chemical Sand Stabilizers

Chemical stabilizers have been used in temperate climates to fix slopes and sand dunes, but have not been used extensively in dry zones, and should therefore be tested before used in hot climates. These products are used to form erosion resistant aggregates and increase water retention in the soil to stimulate plant growth. It is important that these stabilisers are non-toxic, biodegradable and easy to apply. Common used chemicals include: Sandstop, Uresol, Huls, Agrofix, Unosol and Texand.

Flood Management

As mentioned flash flood do occur from time to time in the area, and the wadi bed should therefore not be developed. Roads crossing the wadi are best being constructed in a depression so that debris and water can pass over the roadways during flash flood conditions since it only concerns low frequently storms.Removal equipment maybe required in certain areas after flash floods to clear the road were sand and debris built up has taken place.

A siphon is proposed at the location where the irrigation canal crosses the wadi to prevent flood damage to the conveyance system.

G.6.7 Management of Aquatic Weeds in Channels

The proliferation of water hyacinth is determined largely by two factors, nutrient supply and the absence of natural enemies of the weeds. To be fully effective , control strategies must address both watershed management and direct weed control.

Physical Control

Physical control methods employing manual labour should use long handled tools to prevent the workers from standing in the water and being at risk of contracting Bilharzia.

Mechanical Control

Mechanical weed control includes floating machines such as mowing boats and harvesters. Mowing boats have been developed to control submerged and emergent weeds. One of the most popular cutting machines is the re-ciprocating cutter. The cutters are varying in length and are attached horizontally at a shaft in front of the boat, and then lowered to the required depth. The method works well in Egypt provided the operators are properly trained.

Harvesters basically consist of a barge equipped with a belt type conveyor and suitable cutting machine. These machines are presently used by the MPWWR for controlling weeds in the main channels of the River Nile.

Machines operating from the banks include excavators using an wide digging bucket for reshaping of channels, or special weed-moving buckets which consist of a series of curved vertically arranged reciprocating cutter. Rotary mowers attached to an hydraulic arm are useful for cutting ditchbank weeds on berms and slopes of water channels.

Biological Control

Grass carp can be used as an efficient tool for controlling submerged weeds with additional mechanical control in the summer.

For submerged weed control the water ways should be cleaned thoroughly just before stocking the grass carp. The fish should be stocked at the beginning of the spring shortly after the dry period, and the maintenance period of the irrigation systems. Fencing is usually necessary to keep densities of fish high enough within the stocked reaches when no other barriers are present such as pumping stations or weirs.

Grass carp can also be used to control the intermediate hosts of Bilharzia parasites.

Control of water hyacinth has been proven quite difficult, physical removal has only had limited success since reinfestation from plant fragments and seeds can easily occur. The hyacinth seeds are long lived. Chemical control, now banned in Egypt, required a high input of manpower and mechanical equipment. Further it can result in fish kills or reduced levels of dissolved oxygen caused by decaying weed, biological control therefore looks most promising. The control agents should however been thoroughly researched and proven. And only those agents that have been used extensively and of which experience shows that they can be introduced without risk to crops or their new environment. The cost of introduction of these control agents is comparatively low but projects must be directed by scientists experienced in biological control of water hyacinth.

The NSDO is responsible for canal maintenance and weed control and will need to develop a programme for regular removal and control of weed to maintain the discharge efficiency of the canals. These should include a combination of the mentioned control techniques.

G.6.8 Management of Pesticide Use

Recommended mitigation measures to reduce the effects of pesticides on the environment include restricting use of highly mobile pesticides, setting up training programmes by agricultural extension workers for the safe use of pesticide, and using integrated pest control methods.

Some contamination of groundwater by pesticides is unavoidable, especially in sandy areas, where degradation of pesticides is slow, and mobility is high. It is recommended that pesticides that are highly and moderately mobile in the soil are not used. Some of these are shown in table G.6.1.

Further it is recommended that pesticides with a LD_{50} from 0 to 50 mg/kg (category I pesticides EPA) are banned from the area, and category II pesticides, with a LD_{50} of 50-500 mg/kg, are avoided if possible, since they could affect the health of mammals in the area.

Table G.6.1 Pesticides with High and Moderate Mobility in Soil

Pesticides with high mobility in soil	Pesticide with moderate mobility in soil
aldicarb (Temik)	alachlor (Lasso)
asulam (Asulox)	bromacil (Hyvar)
dalapon (Dowpon)	carbofuran (Furdan)
dicamba (Banvel)	chloramben (vegiben)
hexazinone (Velpar)	chlorfenvinphos (Supona)
methomyl ((Lannate, Nudrin)	chlorsufuron (Glean)
metribuzin (Lexone, Sencor)	EPTC (EPTC)
picloram (Tordon)	ethoprop (Mocap)
TCA	fenamiphos (Nemacur)
tebuthiuron (Spike, Graslan)	MCPA (Weedone)
	MCPB Can-Trol)
	metolochlor (Bicep, Dual)
	monocrotophos (Azodrin)
	terbacil (Sinbar)
	2,4 D

Training of Pesticide Users

Misuse of pesticides can be avoided when farmers are aware of the consequences and are trained about the safe use of pesticides. Farmers should for instance know what weed they are trying to control before selecting and uniformly applying herbicides. Spray equipment should be calibrate carefully, so dosage rates can be controlled. Mixing of pesticides should occur at the correct rates. Spraying on water areas should be avoided and spraying should preferably be carried out after irrigating and not during windy conditions to prevent drifts into watercourses and on to other field. Farmers should be aware of the safe disposal of left over pesticides. A certification scheme for pesticide applicators could be beneficial.

Integrated Pest Control

The use of pesticides can be reduce by using techniques which include other alternative often cultural practices for weed and insect management. Integrated pest control can include crop rotation, poly cropping, species/cultivar selection, crop spacing and canopy manipulation, live mulches and smother crops, alternative timing of planting etc. for alternative control of weeds and insects and thereby reducing the needs for the use of pesticides. For this reason it is recommended that integrated pest control is introduced in the project area. Integrated pest control has already been successfully introduced in Egypt for insect control in cotton.

G.6.9 Management of Diseases

Control of Schistosomiasis (Bilharzia)

Control measures of schistosomiasis can included: treatment by drugs of the infected persons, reduction in the snail population by engineering means, reduction in the snail population by chemical molluscicides, reduction in the release of schistosome eggs into the environment by engineering means, reduction in the need for contact with infected bodies of water by engineering means. The most effective control methods include a combination of the measures mentioned above.

Drugs for the control of schistosomiasis have greatly improved over the last years. These drugs include oxamniquine which is used against *S. mansoni* and praziquantel which is used against all three major schistosome species.

Engineering methods used in controlling snail populations include appropriate channel design, adequate drainage, improved irrigation practices, fluctuation in water levels and construction of barriers to prevent snail drifting.

Channel Design
High mean velocities in the canals could reduce the establishment of snail colonies, and the recommended mean velocity in the canal should be above 0.6 m/s. Dislodging of snails was found to occur at mean velocities of 0.6 to 0.8 m/s. Average velocities at the periphery of the canals are however much lower especially when vegetation is present, and in practice velocities are generally not high enough to prevent snail breeding.

Vegetation in the channels provides a habitat for the snails. Regular removal of the canal weed by mechanical means will destroy or seriously disturb snail habitats. The channel lining will help to reduce vegetation growth and increase the velocity thereby lowering the probability of snail colonisation.

Although the main irrigation canals are usually well designed, the distribution canals often suffer from incomplete planning, design, construction and operation. Snail infestation is often found in these canals.

Adequate Drainage
Snail populations usually colonise drainage systems to a greater extent than irrigation water delivery systems. Lining of drains to increase velocities of use of drainage pipes will reduce or prevent snail growth.

Irrigation Practices
Use of small reservoirs for overnight storage of irrigation water, as proposed, may act as nurseries of producing large numbers of snails and cercariae which are then spread through the area. It is recommended that the reservoirs are designed are large with steep sides and completely emptied daily.

Barriers
Drifting snails in irrigation channels mostly travel very near the surface and near the banks of the canal. Mesh barriers (mesh not coarser than 3 mm) extending down 0.5m from the water surface, which are specially design to capture snails may prevent infestation downstream. However this method is not considered practical in Egypt due to the large amounts of floating objects and trash in the irrigation canals and infestation can still occur by transportation on birds legs and in other ways.

Level Fluctuations
Snail populations can also be controlled by rapidly fluctuating water levels to strand snails on the banks of channels where they may die through desiccation and subsequently flushing downstream by a sudden water level rise.

Chemical Control
Chemical control includes the use of molluscicide to reduce the extent of snail habitats. The cost of this method is proportional to the volume of water to be treated. Two molluscicide used in Egypt are sodium pentachlorophenate and Baylocide (Bayer 73).

Control of Malaria
The main malaria control measures include avoiding creating breeding habitats for the host mosquitoes responsible for transmitting malaria, treatment of infected people and killing of the mosquitoes or the larvae using chemical pesticides and larvicides. Control measures should at first instance focus on the avoidance of creating mosquitoes habitats by providing proper drainage so surface ponding and still standing water does not occur, by controlling aquatic weed growth, by avoiding low velocities in the irrigation and drainage channels, etc.

G.6.10 Wastewater Treatment and Refuse Disposal

Wastewater stabilisation ponds are recommended as one of the widely applicable and advantageous treatment systems in hot climates. These ponds are easy to maintain and are able to absorb shock loads, however they require a considerable amount of space, approximately 0.3 - 0.4 ha/1000 persons. Lining of ponds will be required due to the high permeability of the soil to avoid contamination of groundwater. These systems can produce effluent quality which is suitable for irrigation using natural physical, chemical and biological processes without energy input except energy from the sun.

Refuse collection and disposal systems are not yet common practice in the smaller towns in Egypt. However to avoid increased health risks a collection and disposal system should be developed. This may include central disposal points situated at various locations in the settlements, and collection and disposal of the refuse at a controlled and lined landfill outside the settlement.

G.6.11 Wastewater Effluent Reuse

The level of treatment of effluent that is reused for irrigation depends on the type of vegetation to be irrigated. In the case of utilising the effluent for the watering of windbreaks and shelter belt the WHO guidelines recommend that the water shall only contain one nematode egg per liter (*Ascaris* and *Trichuris* species and hookworms) due to exposure of the workers to the water. As guideline for the treatment is recommended a retention in a stabilisation pond for 8 to 10 days. No standard is recommended for feacal coliform.

TABLE G.6.1 ENVIRONMENTAL EVALUATION MATRIX
INCLUDING PROPOSED MITIGATION MEASURES
(Evaluation Matrix is based on JICA Environmental Guidelines)

Environmental Item	Evaluation	Issue	Mitigation
Social Environment			
1. Resettlement	-B	New settlers will live under harsh conditions, in a remote area	Provide good public facilities and access routes
2. Economic Activity	+A	Increased economic activity, creation of employment opportunities	-Beneficial
3. Traffic and Public Facility	-B	Increase in transportation activities: people, agricultural products and supplies Increase in demand for drinking water and electricity	Provide new roads and access routes Provide additional water and power supply
4. Split of Communities	-B	Bedouins will need to share the area with new settlers Nomadic Bedouins will lose some grazing land for livestock	Provide incentives for local population to participate Provision for easy access to drinking water and fodder for livestock
5. Cultural Property	-B	Possible destruction of two known historical sites	Change proposed canal route Develop a management plan for the excavation and conservation of historic sites in cooperation with the SCA
6. Water rights/Rights of Common	-B	Existing population uses groundwater and tanker water	Provide additional piped water supply for drinking water
7. Public Health Conditions	-B	Introduction of new water borne diseases Reuse of treated wastewater for irrigation could introduce infectious diseases	Provide regular weed control in canals, introduce engineering means to reduce infestation of parasites Provide proper treatment, use for irrigation of wind breaks only
8. Waste	-B	Additional wastewater and refuse produced by new population	Construct wastewater treatment ponds and controlled land fills
Natural Environment			
9. Topography	-B	Levelling of some areas to allow irrigation	Avoid construction activities during May (windy season)

Environmental Item	Evaluation	Issue	Mitigation
9 Topography (continued)		Soil Erosion	Provide temporary erosion control by physically covering
10. Soil	-A	Salinity, infiltration rate Sodium effects	Provide leaching to prevent built up of salts in the soil Monitor chemical composition of soil regularly Add gypsum where necessary
11. Groundwater	-C	Seepage of drainage water may affect Quaternary aquifer at El Arish	Geo hydrological study required to establish management strategies
12. Hydrological Situation	-C	Introduction of irrigation will result in drainage water that may affect groundwater and surface water flows	Geo hydrological study required to establish management strategies
13. Fauna and Flora	-B +B	Displacement of local fauna, no endangered species are known in the area. Creation of new forage area for migratory birds	Create an inland conservation area in the region
14. Meteorology	D		
15. Landscape	+A	Change of desert land into agricultural land	Enhancement of landscape
Pollution			
16. Air Pollution	-B	During construction wind induced soil erosion maybe increased	Prevent construction activities during May (windy season)
17. Water Pollution	-B	Pollution of irrigation water during mixing with drainage water Discharge of drainage water, will have high salinity, high nutrient content, high BOD (if untreated wastewater is discharged to drains)	Provide water quality monitoring system Discharge high saline water to sea Manage fertiliser use to reduce nutrients in water Construct treatment plants
18. Soil Contamination	-B	Indiscriminate use of agro chemicals could result in contamination of soil Disposal excess pesticide Booster pump fuel leakage	Management of pesticide use and fertiliser use to prevent contamination Provide safe disposal facilities for pesticides Provide spill containment at pumps

Environmental Item	Evaluation	Issue	Mitigation
19. Noise and Vibration	-B D	Minor impact during construction No impact during operation	Impact insignificant, no major inhabited areas are present
20. Weeds	-B	Infestation of canals with aquatic weeds	Reduce nutrients in water by management of fertiliser use Provide regular maintenance of canals
21. Sedimentation/ Desertification	-B	Sedimentation of canals due to wind induced soil erosion Desertification can affect cultivated lands Sand storms can affect crops	Provide physical erosion control by covering Contain sand dunes by installing palisades, planting vegetation Provide protection using windbreaks and shelter belts Introduce strip cropping

A = Serious impact expected
B = Some impact expected
C = Extent of impact not known
D = No impact
+/- positive or negative impact

G.7 ENVIRONMENTAL MONITORING PLAN

Monitoring should be carried out during the project implementation and operation of the project to check on the potential impacts of the project and to assess the effects of the mitigation measures.

G.7.1 Water Quality Monitoring

Water quality monitoring of irrigation water, including the reused drainage flows, is important for the management of the irrigation scheme. To be able to determine the equitability of distribution of irrigation water the relation between water demand and supply of users needs to be monitored

The following water quality parameters should be monitored continuously. Electric Conductivity (E.C.), Dissolved Oxygen (DO), pH, and temperature. It should assure that salinity levels do not increase above the target levels.

The possible risks of reusing drainage water have been insufficient quantified. The emphasis has mainly been on one water quality parameter, salinity. The irrigation water will no doubt be used for drinking by animals, or swimming and washing by humans even though the water might not be suitable for these purposes. It is therefore important that coliform levels, BOD loads, and levels of pesticide and heavy metals are also monitored on a regular basis.

The following water quality and quantity data should be collected at various locations:

Damietta Intake	Discharge and Quality
Serw Drain	Quality
Main Canal - Serw Drain downstream of Confluence	Quality
No. 1 & 2 Pumping Station	Discharge
No. 3 Pumping Station	Quality, Discharge
Main Canal-Hadous Drain downstream of Confluence	Quality
Main Canal Bakar Syphon	Discharge
No. 4, 5, 6, 7, Pumping Station	Discharge
Cross Regulators	Discharge
Spillway at 93 km	Discharge
Drainage Water Discharged in Wadi El Arish	Quality
Wastewater Effluents (when reused)	Quality

G.7.2 Soil and Crop Monitoring

The physical and chemical properties of the soil should be monitored to check on the effectiveness of the leaching for salinity and sodium control. It will allow determination of existing conditions with respect and the effectiveness of past irrigation management practices. It will further allow comparison with the salinity and sodium tolerance levels of the crops in question so adjustments can be made to the irrigations. The following aspects should be monitored for the management of soils and crops to avoid salinisation and waterlogging: actual cropped areas and crop water requirements, crop yields, water allocations, the water quality of the irrigation water, the water quality and quantity of the drainage water (especially the nutrient loads), effective operating hours of the irrigation pumps, groundwater levels and salinity. Information on climate such as evaporation rate, temperatures, wind and rainfall are also required for effective irrigation management.

Erosion and sedimentation rates of the soil should also need to be monitored.

G.7.3 Groundwater Monitoring

A groundwater monitoring programme will need to be established to check on the quality of the groundwater. It will also provide the data for the groundwater flow model study recommended below.

It is recommended that a network of observation wells is established that tap into the shallow aquifers to determine the groundwater heads and flows. Periodic water quality sampling should include salinity levels and pollution levels such as pesticides and heavy metals. Although some sampling wells are already present in the region, drilling of a limited number of additional wells may be required.

G.7.4 Weed Infestation Monitoring

The canals should be regularly monitored to determine the rate of weed infestation, sedimentation and the condition of the lining. This will allow maintenance programmes to be adjusted to the weed infestation rate and sedimentation rates in the canals.

G.7.5 Monitoring Related to Public Health

The irrigation and drainage canals should be regularly monitored for the presence of host snails of the schistosomisasis parasite. Monitoring should include assessment of infection of the snails and extent of the invested areas so control measures can be developed. Health checks of the population living in the Project Area could be undertaken to determine the incident rate of the disease in order to assess the magnitude of the disease. Regular reviews of health records of the population in the region should also provide information on reported cases of malaria, filariasis, leishmaniasis, encephalitis and Rift Valley Fever.

G.7.6 Monitoring of Flora and Fauna

Changes in natural vegetation and wildlife populations in the project area and in the wadi should be monitored. Fish population and species in the canals should also be monitored.

G.7.7 Further Studies

It is recommended that a groundwater flow model study is conducted to predict the impacts of groundwater seepage and the drainage water discharge via the Wadi on the aquifers at El Arish. This should include the development of a model to simulate surface flows and groundwater flows and along with the salt - fresh water interface and groundwater quality. (A46. EIA). This may require a geo-electrical survey and pumping tests to determine the hydrogeological parameters of the various subsurface formations.

The model could initially be used to determine the sites of monitoring locations and at a later stage it could be used to assess the environmental impact of the various design and operational scenarios of the irrigation scheme.

G.7.8 Summary of Factors to be Monitored

The factors to be monitored during the operation of the project can be summarised as follows:

- Climate (wind, temperature, rainfall, evaporation, etc.)
- Discharge at project intakes
- Nutrient content of drainage water
- Flow and water levels at critical points in the irrigation system
- Ground water table elevations in project area and downstream
- Water quality of project inflows and drainage flows
- Quality of groundwater in project area
- Water salinity levels in coastal aquifers
- Physical and chemical properties of soil in irrigation area
- Agricultural area in production
- Cropping intensity
- Crop yield per unit of land
- Crop yield per unit of water
- Erosion/sedimentation rates in project area
- Relation between water demand and supply of users (equitability of distribution)
- Condition of distribution and drainage canals (sedimentation, presence of weeds, condition of canal linings)
- Upstream catchment management (agricultural extent and practices industrial activity)
- Incidence of disease and presence of disease vectors
- Health condition of project population
- Changes in natural vegetation in the project area and the surrounding areas
- Changes in wildlife populations in the project area and the surrounding areas
- Fish population in canals

G.7.9 Estimated Cost of Grondwater Monitoring and Study

An approximate estimate for the proposed groundwater study and monitoring is included below. It is envisaged that the study and sampling be undertaken by a local institution such as the Research Institute for Groundwater.

Drilling of test wells, installation of casing etc., Monitoring equipment, Geo-electrical survey to determine lithostratigraphy	LE 100,000
Annual monitoring and sample analysis cost	LE 10,000/yr
Grondwater Flow Model Study	LE 80,000

REFERENCES

1. Set of Laws and Decrees on Pollution
   Includes Law Number 93 of 1962, Law 48 of 1982 and Law 57 of 1978
   Middle East Library for Economic Services.
2. The Executive Regulations of the Law on Environment
   Includes Decrees and Annexes to Law Number 4
   Middle East Library for Economic Services.
3. Law Number 4 of the year 1994, Promulgating a Law Concerning Environment
   Middle East Library for Economic Services.
4. Main Plan for Water Resources Development in Sinai Peninsula
   Ministry of Public Works and Water Resources, 1994.
5. North Sinai Groundwater Resources Study in the Arabic Republic of Egypt,
   Japan International Cooperation Agency, October 1992.
6. The Guinness Guide to Nature in Danger
   Noel Simon and The World Conservation Monitoring Centre Cambridge
   Guinness Publishing, 1993.
7. North Sinai Agricultural Development Project, Environmental Impact Assessment
   Euroconsult in association with Pacer and Darwsih Engineers, commissioned by the World Bank May 1992.
8. Drainage Water, Volume 3 Drainage Water Reuse Project
   Ministry of Public Works and Water Resources
   Water Research Centre, Drainage Research Institute
   March 1993.
9. Australian Guidelines for Fresh and Marine Waters
   Australian and New Zealand Environmental Council
   November 1992.
10. Drainage water Salinity and Recycling in the Nile Delta
    Safwat Abdel Daymen,
    Fresh Water Quality and Efficiency, Optimizing Sustainable Beneficial Use In Selected Arab Countries, Proceedings of Regional Seminar, 17-18 October 1993, Cairo Egypt.
11. Occurrence of Heavy Metals in Some Fish and Water Samples from the River Nile within Damietta Governorate
    Mohammed Ali Zyadah, Environmental Science Department, Faculty of Science, Damietta, Mansoura University, Paper presented at Conference "Environment Protection A Must, Alexandria, Egypt, May 1996.
12. Problems of Aquatic Weeds in Irrigation Systems and Methods of Management
    Ahmed F, Khattab & Zeinab El Gharably.
13. Environmental Action Plan of Egypt, Egypt Environmental Affairs Agency, 1993.

14. Agricultural Situation - Annual Report 1994, American Embassy Cairo, Egypt.

15. Pesticide Residues in the Rosetta Branch of the River Nile during the winter closure period, Paper presented at the conference Nile 2000, Cairo.

16. Sinai Water Resources Study, European Commission, 1993.

17. North Sinai Agricultural Development Project, Feasibility Study Draft Final Report, Volume 2 Part III Agriculture, Annex A6 Land Settlement, Project Preparation Unit GARPAD/Atkins Land Water Management, July 1989.

18. Water Quality for Agriculture, Irrigation and Drainage Paper 29 Revision 1, United Nation Food and Agriculture Organisation, Rome 1985.

19. Weed Management for Developing Countries, Plant Production and Protection Paper 120, United Nation Food and Agriculture Organisation, Rome 1994.

RECORDS OF COMMUNICATIONS

1. North Sinai Development Organisation
   Mr. Mohamed Nabil Nagiub - General Director of Study Sector
2. Egypt Environmental Affairs Agency
   Dr. Abdul Al Rahman Fauzi - Director Water Resources and Coastal Management
   Eng. Tamer Abdel Hamid - EIA Department
3. National Water Research Center
   Dr. Wael Roshdy Soliman - Environmental Specialist
4. Drainage Research Institute
   Dr. Gamal Abd. El Nasser Kamel- Senior Researcher and Head of Laboratories Division
5. Research Institute for Groundwater
   Dr. Nahed El Arabi - Head of Nile Valley Research Department
6. Ministry of Public Works and Water Resources
   Irrigation Improvement Project
   Eng. Essam Barakat - General Director Irrigation Advisory Service
7. Supreme Council of Antiquities
   Abdul Rahman Al Ayedi - Archaeologist
8. National Water Research Center
   Dr. Magdy A Salah El Deen - Senior Researches, Aquaculture and Water Pollution
9. North Sinai Governorate Offices
   El Arish - Governorate Officials
10. Ministry of Agriculture
    Mr. Samir Ahmed Mohamed - Counter part Agriculture and Agro-Processing
11. University of Alexandria
    Prof. Dr. Rawya Monir Kansoh - Head of Civil Engineering, Hydraulics and Irrigation Department
12. North South Consultants Exchange
    Amal Nawar - Translator Administrator
13. US Agency for International Development
    Anne Patterson PH.D - Mission Environmental Officer