APPENDIX-SIX

SEWAGE REUSE FOR CROP IRRIGATION

APPENDIX - SIX

SEWAGE REUSE FOR CROP IRRIGATION

6.1. Present Status of the Jarada Area

1) General

The farm land of the proposed Jarada area is located about 10 km eastwards of the El-Arish city, close to the El-Arish - Rafah road. About ten years ago, in this area, irrigation farming had been conducted utilizing well water, but due to the continuous increase of salt contents in the surface soil layer as well as shortage of irrigation water the farming was abandoned, and presently, rain-fed farming is partly found only during the rainy season.

2) Climate

The climatic conditions in the Jarada area are similar to those which characterize desert areas in other parts of the Northeast region, Sinai Peninsula. They include extreme ardity, long hot rainless summer periods and mild winter in which storms sometimes occur. During winter months the above area experiences short periods of brief but heavy rainfalls that might cause the wadi beds to overflow and wash out roadways, especially in the adjacent area called Wadi El-Arish.

The proposed Jarada area is situated in an area of intense solar radiation and averages only 150 mm of rainfall annually. Low and infrequent precipitation plays an important role in the climate and ecology of the area. Rainfall occurs in the area mainly during the winter season of November to March. Rainfall decreases markedly or is completely non-existent from May to October. In the area, 60 per cent of the rain occurs in winter, while 40 per cent falls during the traditional seasons.

3) Soil

Soils in the Jarada area consist principally of unconsolidated deposits and developed primarily under arid conditions. The soil profiles seldom exhibit evidence of maturity, as reflected by the absence of conspicuous soil horizons.

Originally, soils in the area are eroded by runoff and further cut by wind. Near the coast, the slope levels off to low basins which receive rainwater, but the water soon evaporates. The soils with agricultural potential consist of alluvial aeolian deposition. All soils in the Jarada area have a very low organic matter content, and the water retension capacity is also very low. Most of the soils are exclusively drained.

4) Water Resources

When precipitation is less than about eight to ten millimeters, very little runoff of rainwater is found. Most of this water either evaporates or percolates into the subsoil. When rainfall is more than ten millimeters, runoff may occur, and wadi beds located westwards of the area will begin to carry water depending on the amount and duration of rainfall, the intake capacity of the basin's soils, and their moisture content.

Most potable and irrigation water in the Jarada area is intaken from the ground. Much of the groundwater is high in total dissolved solids or salinity. After a rain, a large part of the flow in the wadies may percolate beneath the surface. Almost all of the groundwater in the area is considered to be from rainfall.

5) Economic Activities

The Jarada area has not been developed to the maximum extent due primarily to lack of adequate water resources. Farming and animal husbandary are the most important subsistence activities in the area. Agriculture is mainly limited to areas where irrigation water is available.

Scattered cultivated plots are also found along wadi beds that receive flood water and are in oasis. The most important agricultural areas near the Jarada area are found in the lower basin of the El-Arish Valley. Major crops grown in the area are citrus, olive, fogs, cucumber, watermelon, okra and others. In the area, part of cultivation is carried out by bedouin farmers. Wind-blown soil found underbeneath the sand, together with the high water table, allows farmers to grow thousand of date palms, vegetables such as cucumber, tomatoes and watermelon.

Traditional animal husbandary in the area is based on the use of natural vegetation for rearing goat, sheep and camels. The current estimate of the livestock population is very nearly the same as the estimate of human population.

6.2. Soil Study

(1) General

Soil study on the agricultural development for effluent reuse was carried out during the investigation period of July to October, 1984. The study is largely divided into four, namely 1) Reconnaissance survey; 2) Soil survey at the feasibility study level; 3) Soil analysis; and 4) Overall study.

Reconnaissance survey was conducted at the initial stage of the field investigation period for the selection of potential farm lands from the effluent reuse's viewpoint in four areas called 'Lower Wadi El-Arish', 'Area adjoining Lower Wadi El-Arish on the west', 'Middle Wadi El-Arish' and 'El-Arish - Rafah strip area'.

Soil survey at the feasibility study level was conducted for about 15 days of September and October, 1984 in the proposed farm land extending in the Jarada area which was selected as the most high potential farm land among the above-said four kind of the areas.

The soil survey involves stick boring surveys at 45 sites and soil profile surveys at 15 sites in the specified farm land of the Jarada area. In conducting the above soil survey, soil samples of 21 in total were taken at the seven sites of the profile soil survey.

Soil analysis was conducted on soil samples of 21 utilizing a portable soil test kit in October, 1984.

Overall study was conducted in due consideration of the result of the above-said survey and analysis in October, 1984.

(2) Soil unit

In the proposed Jarada farm land the main soil unit was identified to be composed of Dystric Regosols which are distributed over shifting sand dunes and occupy almost all of the farm land.

According to our study, the parent material is wind blown sand. Although this soil unit is originally derived from fluvio-marine alluvium, it is not residum. The topographic features are diverse and range from nearly flat to gently undulating to gently rolling.

As seen in the figure with some description of the representative soil profile (No.6), the fine aeolian sandy lamina is recognized from the surface to a 80 cm depth of the profile. The soil profile seldom exhibit evidence of maturity, as reflected by the absence of conspicuous soil horizons. The soil texture is mainly Sand (S). The matrix colour ranges from bright brown (7.5 YR 5/8) to yellow orange (7.5 YR 7/8) of which the latter dominant.

The solid ratio of the soil unit represents a relatively high value and the porosity low slightly, but the compactness of the profile, especially in the lower layers, is often loose. Due to the coarse texture under non-moisture states, the packing of soil particles is rather compact, but the cohesion between soil particles is low. Judging from the air ratio at pF 1.5, the water permeability of the profile seems to be very high.

Representative Soil Profile (No.6)

Date of Field Survey	:	20 September, 1984
Location	:	500 m north-east site from the proposed chlorination tank attached to the sewage treatment plant
Surrounding Land	:	Shifting sand dune, flat
Land Use	:	Desert
Parent Material	:	Aeolian sand originated alluvium
Great Soil Group	:	Dystric Regosols (Rd), deep sandy phase
Soil Series	:	Shifting sand dunes

Description of Profile

0 - 80 cm	No conspicuous soil horizons, no gravel, no humus, soil texture Sand (S), matrix colour 7.5 YR 7/8 yellow orange, no mottle, many fine pores, structureless single particle, permeability fairly free

6.3. Land Resources in Northeast Region, Sinai Peninsula

Lands extending in the Northeast region of the Sinai Peninsula are largely divided into two, namely 1) the lower elevation sandy plains (up to 300 m), and 2) the higher elevation valleys and plains (above 300 m). In general, lands scattered in and around the El-Arish area belongto the lower elevation sandy plains mentioned above. According to the report (Ref. No.4), land resource units found in the lower elevation sandy plains of the Northeast region are C, D, F, G, H and J, of which the outlines are described as shown in the attached table.

Candidate areas for irrigated agriculture are widely spread in the lower elevation sandy plains. The highest rated soils (only a limitation) are found in Units C, H, D and G. It is reported that Unit C (the Lower Wadi El-Arish) has the best soils of the Sinai Peninsula. Although moderately high salinity of the surface layer is the only important limitation, this can be easily overcome due to the excellent subsoil drainage for leaching water.

It is also reported that there are at most 324,000 feddans in Units C, D, G and H (primarily below 300 m elevation) which are likely to support irrigated agriculture under careful management. However, none of these units has enough underlying groundwater to realize more than a small fraction of this potential. Unit G comes closet to having enough (14 per cent of requirement, assuming 7,500 cubic meters/feddan/year), but most of this groundwater is already committed to support the urban requirements of the El-Arish area.

Judged from the studies conducted by the Ministry of Development, A.R.E. and others, the farm lands in the El-Arish area considered as candidate for irrigation are as follows:

Areas of Land Resource Units and their Landforms in El-Arish Area

Land Resource Unit	Component Landforms	Area (feddan)	Candidate for Irrigation
C	alluvial plain (40%)	699,000	no
	sand sheet (40%)	699,000	yes
	active wade beds (20%)	349,000	yes
D	sand dunes (30%)	149,000	no
	alluvial plain (15%)	74,000	no
	active wadi beds (15%)	74,000	yes
F	rock outcrop (90%)	442,000	no
	aeolian sand (10%)	49,000	no
G	aeolian sand sheet and dunes (40%)	14,000	no
	alluvial soil on lower terraces (40%)	14,000	yes
	alluvial soil on higher terraces (20%)	7,000	no
H	Aeolian sand sheet (30%)	220,000	yes
	mobile sand dunes (30%)	220,000	no
	coastal beach and wet sabkha (25%)	183,000	no
J	sandy dry sabkha (10%)	73,000	no
	lagoonal sediments (5%)	37,000	no

6.4. Classification of Production Capability

For the clarification of the kind and the extent of limitations that impede the crop production, production capability classification was carried out on the basis of the soil classification mentioned separately.

In classifying production capability, soils were grouped into four classes in due consideration of the presence of restrictive or impeding factors towards normal crop production. Each is defined as follows:

Class I : Nearly impossible to ameliorate.
Soils that have some limitations such 'exposed bedrock' and 'shallow depth of less than 1 m to bedrock'.

Class II : Impractical or costly to ameliorate.
Soils that have many limitations or hazards such as 'mobile dunes', 'shallow depth of less than 1 m good quality water table' and 'extremely saline soils as greater than 100 mmhos/cm'. But the soils could be utilized for producing some crops under very intensive ameliorative practices.

Class III : Practical with some ameliorative techniques.
Soils that have some limiting factors or hazards such as 'slope of more than 20%', 'gravel of about 10% of soil surface', 'flood following rain', 'coarse texture as rapid permeability throughout profile', 'high salinity of 10 mmhos/cm or greater', 'high calcium carbonate of 30% or greater', and 'high exchangeable sodium of 20% or greater'.

Class IV : Manageable with standard techniques.
Soils that have nor or a few limiting factors or hazards compared to those in Class III, and are regarded as either being naturally fertile high potentiality in the crop production without any ameliorative practices.

6.5. Site Identification Criteria on Potential Farm Land for Effluent Reuse in the Jarada Area

Location	Criteria
Land Availability	The proposed site must be available for direct or indirect control by the Governorate of North Sinai
Land Use	Cultivated areas are preferred rather than undeveloped desert land
Land Area Requirements	About 600 feddans and collective land is preferrable
Soils, Geology and Groundwater	The key soil factor for preliminary site identification is permeability. Besides, texture, effective depth, drainage, available water holding capacity, salinity, alkalinity, groundwater availability, etc. are to be considered.
Site Location	The selected location should be near the effluent source and the points of ultimate disposal and/or reuse.

6.6. Limitations for Crop Cultivation under Irrigation

First Class Soil Limitations: (Nearly impossible to remedy)	--	Exposed bedrock
	--	Shallow depth (less than 1 meter) to bedrock
Second Class Soil Limitations: (Impractical or costly to remedy)	--	Mobile dunes
	--	Shallow depth (less than 1 meter) good quality water table
	--	Shallow depth (less than 3 meters) to saline water table
	--	Extremely saline soil (greater than 100 mmhos/cm)
Third Class Soil Limitations: (Manageable with standard techniques)	--	Slope (8-30%)
	--	Gravel (more than 20% through profile)
	--	Surface stones, including boulders (covering more than 10% of soil surface)
	--	Hard pan (less than 3 meters below surface)
	--	Flooding likely following rain
	--	Coarse texture (rapid permeability through profile)
	--	High salinity (10 mmhos/cm or greater)
	--	High calcium carbonate (30% or greater)
	--	High exchangeable sodium (20% or greater)

6.7. Rainfed and Irrigated Crops in the El-Arish Area

Kind of Crops	Acreage	Remarks
Rainfed		
Date Palm	About 100,000 trees yielding 300 tons	Consumed by bedouin as nutrious, storable food
Barley	About 1,000 feddans	Utilized as local grain and fodder
Berseem and Alfalfa	Variable according to rainfall	Cultivated by traditional method, and utilized as feed
Watermelon	Variable according to rainfall	Utilized as human and animal food
Castor Beans to rainfall	Variable according	Used for oil
Irrigated		
Olive	700 feddans	Used for pickling and oil. Traditionally planted in low density (40 trees/feddan). Intercropped during the period of young trees. Irrigated by basin method and drip method.
Vegetables	700 feddans	Consumed locally. Representatives are tomatoes, marrow, cucumber, pepper, okra, egg plant, potatoes, etc. Irrigated by drip method.
Fruits	200 feddans	Consumed locally. Main fruits are apricots, apples, guava, grape-vines, etc. Irrigated by drip method.

6.8. Selection of Suitable Crops on the Basis of Law and Decrees Concerned

According to the KUP report, the following crops were selected for the agricultural development in the Jarada area taking into account the request of Department of Agriculture, Governorate of North Sinai.

Cereals	:	barley and wheat
Forage crops	:	green alfalfa
Vegetables	:	tomatoes and cabbages
Fruits	:	melon, orange, olive and fogs

Of these crops, tomatoes and cabbages are usually consumed in a raw state.

Standards applicable directly to treatment plant effluent have been not yet available except for a few examples in some countries such as U.S.A., Federal Republic of Germany, Israel and South Africa. Some representative standards for the reuse of treatment plant effluent are as shown in Table 3.6.2 of the main report.

As seen in the table, direct use of treatment plant effluent towards crops for human consumption in a raw state is strictly prohibited in almost all of the countries even though the effluent is treated tertiarily.

In Egypt, the use of treatment plant effluent for irrigation is regulated by Law No. 93 of 1962 and its executive regulations issued by Decree No. 649 of 1962 (Ministry of Housing).

In Chapter Six of the Law's executive regulations by decree No. 649 of 1962, the norms and specifications required in liquid waste that is intended for surface irrigation or fur irrigation of agricultural lands are dealt. According to the above-said decree, it is prohibited to cultivate vegetables and fruits which are consumed in a raw state under irrigation utilizing treatment plant effluent.

Taking into consideration the present status and marketability as well as the above matter, in our study, the appropriate crops were selected for agricultural production as given below.

Winter crops	:	berseem, barley, potatoes and broad beans
Summer crops	:	okra, watermelon and green pepper
Perennial crops	:	citrus, olive and alfalfa

6.9. Irrigation Requirements

Irrigation requirements are worked out multiplying crop water requirements (net irrigation requirements) by irrigation efficiency. In this study, the crop water requirements were calculated utlizing Blaney-Criddle Method on the basis of the report prepared by KUP Engineer Consul, Federal Republic of Germany, in 1983 in due consideration of 'Pan Evaporation Method' authorized by Food and Agriculture Organization of the United Nations, and the related various useful data available in Egypt.

Climatic data such as evaporation, humidity, wind velocity and others were obtained from the Meteorological Station at the El-Arish city. According to our calculation, the peak water requirements (weighted mean in June) reach 7.00 mm/day or 29.4 m^3/day/fd and the annual total is 6.103 m^3/year/fd. These amounts mean net irrigation requirements. Each crop water requirement varies 2.24 mm/day of potatoes in winter to 8.73 mm/day of green pepper in summer and 9.45 mm/day of perennial alfalfa. Crop water requirements calculated for this study are tabulated in the following.

Crop Water Requirements

Period	Kind of Crops	Occupied Acreage	Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
			ETo	2.8	3.9	4.5	5.25	7.8	8.8	9.0	8.8	7.8	5.4	4.5	3.2
		(%)		(mm/day)											
Winter	Berseem	10	kc	1.10	1.10	1.10	0.97						0.75	0.90	1.10
			ETc	3.08	4.29	4.95	5.09						4.05	4.05	3.52
	Barley	10	kc	1.15	0.60								0.63	0.70	1.15
			ETc	3.22	2.34								3.40	3.15	3.68
	Potatoes	5	kc	0.80	0.98	1.20	1.12								0.72
			ETc	2.24	3.82	5.40	5.88								2.30
	Broad beans	10	kc	1.20	0.75									0.92	1.15
			ETc	3.36	2.93									4.14	3.58
Weighted Mean (Sub-Total)															
			ETc	0.98	0.77	0.55	0.80						0.75	1.13	0.86

Crop Water Requirements

Period	Kind of Crops	Occupied Acreage	Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
			ETo	2.8	3.9	4.5	5.25	7.8	8.8	9.0	8.8	7.8	5.4	4.5	3.2
		(%)		(mm/day)											
Summer	Okra	5	kc				0.60	0.65	1.00	0.65	0.10				
			ETc				3.15	5.07	8.80	5.85	0.88				
	Water-melon	20	kc				0.65	0.65	0.95	0.75	0.16				
			ETc				3.41	5.07	8.36	5.85	1.41				
	Green pepper	10	kc				0.65	0.65	0.95	0.65	0.16				
			ETc				3.41	5.07	8.36	8.73	1.76				
	Weighted Mean (Sub-Total)														
			ETc				1.18	1.78	2.95	2.34	0.50				

Crop Water Requirements

Period	Kind of Crops	Occupied Acreage	Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
			ETo	2.8	3.9	4.5	5.25	7.8	8.8	9.0	8.8	7.8	5.4	4.5	3.2
		(%)		(mm/day)											
Perennial	Citrus	10	kc	0.85	0.85	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.90	0.90
			ETc	2.38	3.32	4.05	4.73	7.02	7.92	8.55	8.36	7.41	5.13	4.05	2.88
	Olive	30	kc	0.85	0.85	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.90	0.90
			ETc	2.38	3.32	4.05	4.73	7.02	7.92	8.55	8.36	7.41	5.13	4.05	2.88
	Alfalfa	10	kc	0.65	0.65	0.65	1.00	1.00	1.00	1.00	1.05	1.05	1.15	0.75	0.70
			ETc	1.82	2.54	2.93	5.25	7.80	8.80	9.45	9.24	8.19	6.21	3.38	2.24
	Weighted Mean (Sub-Total)														
			ETc	1.13	1.58	1.91	2.42	3.59	4.05	4.38	4.27	3.78	2.67	1.99	1.38
	Weighted Mean (Total)														
			ETc	2.11	2.35	2.46	4.40	5.37	7.00	6.72	4.77	3.78	3.42	3.12	2.24
	Net Water Demand (m^3/day/fed)														
			ETc	8.9	9.9	10.3	13.5	22.6	29.4	28.2	20.0	15.9	14.4	13.1	9.4

Note: 1. Total weighted mean: 1,452 mm/year ; 2. Net water demand: 6,103 m^3/year/fed

6.10. Relative Tolerance of Various Crops to Soil Salinity

Fruit Crops

High salt tolerance	Medium salt tolerance	Low salt tolerance
Date palm	$ECe \times 10^3 = 8$	$ECe \times 10^3 = 4$
	Pomegranate	Pear
	Fig	Apple
	Olive	Orange
	Grape	Grapefruit
	Cantaloup	Prune
		Plum
		Almond
		Apricot
		Peach
		Strawberry
		Lemon
		Avocado
$ECe \times 10^3 = 8$	$ECe \times 10^3 = 4$	$ECe \times 10^3 = 2$

Vegetable Crops

High salt tolerance	Medium salt tolerance	Low salt tolerance
$ECe \times 10^3 = 11$	$ECe \times 10^3 = 10$	$ECe \times 10^3 = 4$
Garden beets	Tomato	Radish
Kale	Broccoli	Celery
Asparagus	Cabbage	Green beans
Spinach	Bell pepper	
	Cauliflower	
	Most lettuce	
	Maize	
	Potatoes	
	Carrot	
	Onion	
	Peas	
	Marrow	
	Cucumber	
$ECe \times 10^3 = 10$	$ECe \times 10^3 = 4$	$ECe \times 10^3 = 3$

Field Crops

High salt tolerance	Medium salt tolerance	Low salt tolerance
ECe $\times 10^3$ = 16	ECe $\times 10^3$ = 10	ECe $\times 10^3$ = 4
Barley	Rye (grain)	Field beans
Sugar beet	Wheat (grain)	Sugar cane
Rape	Oats (grain)	Cassava
Cotton	Most rice	
	Sorghum (grain)	
	Maize	
	Flax	
	Sunflower	
	Castor beans	
	Soy beans	
ECe $\times 10^3$ = 10	ECe $\times 10^3$ = 6	

Forage Crops

High salt tolerance	Medium salt tolerance	Low salt tolerance
ECe $\times 10^3$ = 18	ECe $\times 10^3$ = 12	ECe $\times 10^3$ = 4
Alkali sacaton	White sweet clover	White Dutch clover
Salt grass	Yellow sweet clover	Meadow foxtail
Nuttal alkali grass	Perennial ryegrass	alsike clover
Bermuda grass	Mountain brome	Red clover
Rhodes grass	Strawberry clover	Ladino clover
Fescue wildrye	Sudan grass	Burnet
Canada wild rye	Sudan grass	
Western wheatgrass	Hubam clover	
Barley (hay)	Alfalfa (Calif. common)	
Birdsfoot trefoil	Tall fescue	
	Rye (hay)	
	Wheat (hay)	
	Oats (hay)	
	Orchardgrass	
Blue grama	Blue grama	
	Meadow fescue	
	Reed canary	
	Big trefoil	
	Smooth brome	
	Tall meadow oatgrass	
	Cicer Milkvetch	
	Sourclover	
	Sickle milkvetch	
ECe $\times 10^3$ = 12	ECe $\times 10^3$ = 4	ECe $\times 10^3$ = 2

(Source): FAO (1979) from Richards et al. (1954).
Quoted from 'SINAI DEVELOPMENT STUDY' (1983).

6.11. Possible Blending and Changing Treatment Plant Effluent as Irrigation Water

Generally, problems on hazards derivable from excessive quantities of nitrogen, suspended substances, chemical oxygen demand, and others are most easily solved by abandoning the problem water supply and substituting a better quality one. In many cases, however, an alternative source of good quality may not be available. If an alternative source of water is available, blending becomes possible. The resulting concentration can then be evaluated by means of the Guidelines shown in Table 3.6.3 of the Main Report.

An example calculation for blending is given below:

Example:

'Treatment plant effluent' is available to blend with 'Well water' to the extent of 70% treatment plant efluent and 30% well water. What is the quality of the blended water?

Given	BOD (mg/l)	SS (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)	ECw (mmhos/cm)
Effluent	27	37	44	24	7	3.6
Well water	0	1	0	0	0	0.1

Calculation:

BOD = (2.7 x 0.7) + (0 x 0.3) = 18.9 mg/l (blend)
SS = (37 x 0.7) + (1 x 0.3) = 25.9 + 0.3 = 26.2 mg/l (blend)
COD = (44 x 0.7) + (0 x 0.3) = 30.8 mg/l (blend)
Total Nitrogen=
(24 x 0.7) + (0 x 0.3) = 16.8 mg/l (blend)
Total Phosphorus=
(7 x 0.7) + (0 x 0.3) = 4.9 mg/l (blend)
ECw = (3.6 x 0.7) + (0.1 x 0.3) = 2.52 + 0.07 = 2.59 mg/l (blend)

6.12 Management Alternatives for Irrigation Water High in Nitrogen

When excessive quantities of nitrogen are contained in irrigation water, necessary countermeasures must be taken for the success of the crop cultivation. Major countermeasures are as mentioned below.

1) Application of nitrogen non-sensitive crops rtather than sensitive crops.

2) Actual fertilizer application rates of nitrogen to crop should be determined in due consideration of an amount obtainable from the irrigation water. Please note that ammonium-nitrogen is seldom present at more than one mg/l unless ammonia fertilizer or sewage effluent is added to the water.

3) Study and execution of blending and changing irrigation water to reduce nitrogen to more acceptable levels where and when an alternative water source is available. In general, crops are not sensitive to nitrogen at all stages of the growth. Therefore, in the early plant growing seasons, nitrogen contained in irrigation water is consumed as a fertilizer, but during the late plant growing seasons excessive nitrogen may cause problems.

4) Denitrification may be possible but is not often used.

6.13. Hazards Derivable from Excessive Quantities of Nitrogen in Irrigation Water

Nitrogen in irrigation water acts the same as fertilizer nitrogen and excesses will cause problems just as fertilizer excesses cause problems. Production of nitrogen sensitive crops may be affected at nitrogen concentrations above 5 mg/l nitrogen (5 kg N per 1,000 m^3 of water) from either nitrate or ammonium. Watermelon, for example, under excessive nitrogen fertilizer grows too vigorously and the yield is reduced, or barley is late in maturing. Maturity of citrus may also be delayed and fruit may be poorer in quality. For many grasses, lodging may appear due to excessive vegetative growth.

At more than 30 mg/l nitrogen (30 kg N per 1,000 m^3 of water), severe problems are expected with nitrogen sensitive crops. For crops not sensitive, more than 30 mg/l nitrogen may be adequate for high crop production and little or no fertilizer nitrogen may be needed. Less than 5 mg/l nitrogen has little effect even for the nitrogen sensitive crops. However, algae and aquatic plants in streams, lakes, ponds, pipelines and canals are often stimulated and when temperature, sunlight and other nutrients are optimum, very rapid growth or algae blooms can occur. The excessive growth may result in plugged pipelines, sprinklers and valves to the point that either mechanical controls, such as with screens and filters, or chemical control such as with copper sulphate may be necessary.

6.14. Pre-leaching Applicable for Farm Lands in the Jarada Area

In arid and semi-arid zones, salts often accumulate in the top layer of the surface soil during non-crop periods. Where high water tables complicate salinity control, fallow and idle lands may rapidly accumulate surface salts particularly in hot arid climates. Under such conditions, crop germination may be disturbed, and consequently the yield can be seriously reduced.

Crop germination and early crop growing can be promoted by a heavy pre-plant irrigation for leaching salts accumulated on the surface soil. In view of the above, it is considered that a heavy pre-plant irrigation is an essential practice for leaching. It is made far enough in advance of the desired planting date to allow for cultivation to remove weeds and preparation of a seed bed.

It is desirable to apply an irrigation to farm lands affected with salts. By this irrigation, the soil profile is filed with water, and the winter rains provide excess water for leaching. This technique is particularly beneficial for leaching.

6.15. Example of Effluent Reuse Scheme

As mentioned in the main report, the Rhodes grass irrigation experiment was carried out during 1978 and 1979 at the Gan Rave sand dune experiment station in the coastal plain of Israel. Wastewater for irrigation, which originated from the municipality of Rehovot, was circulated in three oxidation ponds(secondary treatment), and was pumped from the third pond after about two weeks of detention.

There were four irrigation treatments - 60, 80, 100 and 120% - of Class A pan evaporation. Two levels of N fertilization - 0 and 700 kg N (applied as ammonium sulphate)/ha in 1978, and 250 and 500 kg N/ha in 1979 - were applied in equal portion after each cutting from June until September. In addition, 600 kg/ha of superphosphate was applied to the soil.

The average quantity of water used for irrigation each year was 5,510, 6,540, 8,190 and 9,580 m^3/ha for the 60, 80, 100 and 120% irrigation treatments, respectively. Average N applied in the wastewater was 99.2, 117.7, 147.4 and 172.4 kg/ha for the four irrigation treatments, respectively.

Two free-drainage lysimeters, L_1 and L_2 (120 cm deep and 100 cm diam), were installed in a high-water-quanitity plot, one in the low-N (L_1) and one in the high-N subpot (L_2). A rain gauge was placed on each lysimeter to measure the irrigation water. Because of variations in irrigation efficiency due to winds and changes in line pressure, the lysimeters received quanitities varying from 45 to 105% of pan evaporation. Soil moisture under each treatment, and also on the lysimeters, was measured with a neutron scattering meter. Winter rainfall was 463 mm (1977/78) and 230 mm (1978/79).

Samples of irrigation and drainage water as well as of plant and soil material were obtained periodically for chemical analysis. Potassium and sodium were determined with an EEL flame photometer; NO_3, NH_4 and PO_3 by a Technicon autoanalyzer; Cl' with a chlorimeter; and Ca and Mg with a Perkin-Emer 460 Atomic adsorption spectrophotometer.

Remarks:

In Israel, in 1978 and 1979, a field experiment on utilizing treatment plant effluent was carried out on a sand dune with Rhodes grass (Chloris gayana Kunth). The main purpose of this experiment was to study the possible utilization of treatment plant effluent as a source of irrigation water for Rhodes grass growing on a sand dune soil without causing groundwater pollution.

According to the result, it was cleared that irrigation of Rhodes grass with treatment plant effluent is an effective means of disposing of water safety, reducing pollution hazards, and simultaneously obtaining a high yield of dry matter for animal feed. It was also cleared that water requirements of the crop are known, the hazards of leaching salts into the groundwater will be reduced.

(Vaisman, I., Shalevet, J., Kipnis, T., and Feigin, A. 1981 Reducing Groundwater Pollution from Munincipal Wastewater Irrigation of Rhodes Grass Grown on Sand Dune. J. Environ. Qual., 10:434-439)

6.16. Land Application System of Wastewater

According to the report 1/, it is said that several land application systems including crop irrigation utilizing treatment plant effluent, rapid infiltration and overland flow have the potential to treat, dispose or utilize wastewater effectively as a conventional treatment.

Crop irrigation utilizing treatment plant effluent as planned for the farm land of the Jarada area is a most desirable one and operationally similar to standard irrigation practice. It is noticeable, however, that this system is not always desirable for poor drainage and steep topographic areas.

Rapid infiltration is one of the land application systems to treat wastewater. The wastewater is, first of all, ponded in a basin and then treated by a combination of physical, biological and chemical processes in the soil layers. In case of rapid infiltration, it requires a moderate to highly permeable, deep soil that is flat or has mild slopes.

Practically, no valuable cash crop might be grown, but some kind of forage crops are often planted as an aid to infiltration if water quality of the wastewater could fit many of items mentioned in the Guidelines (Re: Table 3.6.3 of the main report). Special characteristics of this system is the periodic drying cycle. In ths cycle, soil reaeration and simultaneous decomposition of accumulated solids will be promoted.

Overland flow is also one of the land application systems. This is utilized as a treatment rather than a reuse or disposal method. In this system, wastewater ia applied over the upper reaches of sloped terraces and allowed to flow across a vegetated surface to collection ditches.

1/ : Rehabilitation and Expansion of the Canal Cities Wastewater Systems -- Suez Feasibility of Land Application -- Prepared by National Organization for Potable Water and Sanitary Drainage.

6.17. Calculation of Acreage Necessary for Irrigation Applying Treatment Plant Effluent

According to the report prepared by KUP, acreage necessary for irrigation applying treatment plant effluent has been calculated by the following formulae.

1) $Q_{irr} = Q \times C$

where,

Q	= Swwage quantity per year
Q_{irr}	= Available water quantity for irrigation on the field
C	= Efficiency of irrigation systems

2) $A = Q_{irr} / ET_c$ 1/

where,

A	= Acreage necessary for irrigation
ET_c	= Water consumption of barley (winter) in mm/year

On the assumption that sewage quantity is 7,300,000 m^3/year, and drip irrigation system is applied, the actual calculation is as follcws.

$$Q = 7{,}300{,}000\ m^3/year \times 1.0 = 7{,}300{,}000\ m^3/year$$

$$A = Q_{irr} / ET_c \times 10{,}000 = 7{,}300{,}000 / 1.352 \times 10{,}000$$
$$= 539.9\ ha \doteqdot 540\ ha$$

1/ : Calculated in accordance with the procedure mentioned in the KUP report (Re: pp.33, Vol.4 "Re-Use of Treated Sewage" of the report)

Towards this calculation, in our study, the following procedure has been applied.

Irrigation efficiency (E_i) mentioned in the KUP report as C (Efficiency of irrigation systems) has been worked out at 0.9 against 1.0 used in the KUP report. According to our study, 0.9 is explained as follows:

"Irrigation efficiency (E_i) is a product of conveyance efficiency (E_c) and field application efficiency (E_a). Conveyance efficiency (E_c) in the farm land of the Jarada area is expected to be above 95 per cent in view of the soil conditions and related factors. Generally, field application efficiency (E_a) of the drip system is designed at a level of 95 to 100 per cent in case of fields and green houses. In the farm land of the Jarada area, it is assumed at 95 per cent in due consideration of the field cultivation. The irrigation efficiency (E_i) is determied as below: "

$$E_i = E_c \times E_a = 0.95 \times 0.95 = 0.903 \doteq 0.90$$

In the meantime, in the KUP report, acreage necesary for irrigation has been obtained dividing available water quantity for irrigation on the field ($\bar{Q}_{irr}$) mentioned in Formula 1) of the report by water consumption of barley in mm/year.

Towards this method, in our study, first of all, the irrigation requirements have been worked out utilizing the following formula.

$$q = ET_c \times 4.2 \times 1/E_i \times 1/86,400 \times 24/T_i$$

where,

- q = irrigation requirements (l/sec/fd)
- ET_c = crop water requirements (mm/day)
- E_i = irrigation efficiency -- 0.9 in case of drip system
- 4.2 = ratio of conversion in feddan
- T_i = irrigation hours -- 24 hours in case of drip system

Therefore,

$$q = 7.0 \times 4.2 \times 1/86,400 \times 1/0/9 \times 24/24 = 0.3781 \text{ l/sec/fd} \quad \underline{1/}$$

According to the proposed treatment plan, an amount of effluent derived from the treatment plant is estimated at 20,000 m^3 per day, nearly equal to 0.231 m^3/sec. As the irrigation requirements are 0.3781 l/sec/fd as mentioned above, irrigation for farm lands of 611 feddans (257 ha) will become possible as below.

$$\text{Irrigable acreage} = 0.231 \text{ m}^3\text{/sec} / 0.3781 \text{ l/sec/fd}$$
$$= 611 \text{ feddans (257 ha)}$$

As seen in the above, with regards to irrigable acreage, there is a difference between our study and the KUP report. Judged from various aspects concerned, it is assumed mainly due to the difference of cropping patterns applied respectively. It must be also noted that in the KUP report, 1.0 as "Efficiency of irrigation systems" has been applied, and in calculating the irrigable acreage "Available water quantity for irrigation on the field" has been directly divided by "Water consumption of barley in mm/year".

1/ : Peak water requirement (weighted mean in June) calculated in our study. This has been calculated on the basis of "Cropping Pattern" mentioned in the main report different from one pattern of barley seen in the KUP report.

6.18. Jarada Experimental Farm

. General

Jarada Experimental Farm performs the functions mentioned in the main report, and is expected to play a role of vital importance on crop cultivation utilizing treatment plant effluent. Activities of the farm will be promoted to include various trials and other works required for the development of the North Sinai region as well as the El-Arish area when the extension activities eventually come to cover these areas.

Staff composition for the operation of the Jarada Experimental Farm is as shown below.

Post	Status	Egyptian Side	Foreign Side
Farm Manager	Technical Officer Irrigation Engineer	1	
Agronomist	Specialist		1
Agronomist	Technical Officer Agronomist	1	
Agro-economist	Specialist		1
Agro-mechanic	Technical Officer	1	
Junior Technician	Technical Officer	2	
Administrative Assistant		2	

Note: Short-term specialists are not included in the above table.

The farm manager assumes overall responsibility for the operation and management of the farm. Japanese experts assist him in the discharge of their duties and provide guidance and instruction to Egyptian staff to help achieve the purpose of the farm.

In addition to the above-listed officers and technical staff, store keeper, jeep and truck driver, tractor operator, field foreman, guard, office boy, assistant mechanics and farm labourer are to be employed on the responsibility of the Governorate of North Sinai.

Trials on Improved Farming Practices

Improved farming techniques will be put to trials at the Jarada Experimental Farm to provide practical means of crop cultivation utilizing treatment plant effluent. Problems to be put to trials at this farm will be essentially those which are encountered in the arena of the actual crop cultivation.

Such problems will be finally discovered by farmers in their own field or other places and conveyed directly to the Jarada Experimental Farm or through the relevant extension workers. In other cases, they may detected by Egyptian technicians or Japanese staff participating in the experimental farm activities.

Considering the nature of the farm, it is desirable that trials be made on problems finally encountered by farmers. In the initial stages, however, trials will be made chiefly on the problems discovered by Egiptian technicians and Japanese staff.

Activities to be made at the Jarada Experimental Farm in the immediate future are described below. In this connection, it is to be noted that the kind of problems to be put to trials will be naturally reviewed, screened and increased in the course of the farm's future management and during the survey for detailed design.

Experiment:

- # Study on standard dosage of fertilizer by crops
- # Study and establishment on control measures against plant diseases and insect damages
- # Measurement for determining optimum supply of irrigation water by crops
- # Study on best cropping season by crops
- # Study on cultivation method, seeding time and seeding rate by crops
- # Blending of treatment plant effluent
- # Others

Demonstration:

- # Cultivation techniques for attaining highest yield
- # Ear maturing fertilization techniques
- # Weeding
- # Water saving culture
- # Green tree planting
- # Others

6.19. Labour Requirements by Crops per Feddan

(man-day)

Crops	Minimum	Medium	Maximum
Cereals			
Wheat	1	5	28
Barley	1	5	28
Corn	4	10	37
Rice	-	-	57
Forages and Legumes			
Berseem (long)	10	20	35
Berseem (short)	4	7	14
Sudan Sorgum	10	20	35
Beans and Grain	10	20	22
Beans for Forage	4	7	12
Industrial Crops			
Cotton	35	60	85
Sugar Beet	20	40	60
Oil Crops			
Peanuts	20	35	59
Sunflower	18	23	28
Vegetables			
Onion	43	50	62
Tomatoes	44	52	64
Watermelon	45	53	68
Potatoes	42	50	58
Fruits			
Citrus	65	75	150
Mango	50	60	150
Grapes	35	40	100
Date Palm	20	25	70

6.20. Agricultural Organization in North Sinai, 1983

Organization	Size and Function
Wadi El-Arish Agricultural Cooperative	793 member-families cultivate 4,265 feddans. Distributes animal feed, fertilizers, insecticides. Markets dates and olives.
Agricultural Cooperative for Vegetables & Fruit Production	600 members (some also in above cooperative). Seasonal activities - auctions of dates and olives, olive oil.
Bir El-Abd Cooperative	Sells dates.
El-Salaam Cooperative	344 feddans
Agricultural Directrate - North Sinai Governorate	Agricultural extension, veterinary services, land tenure, legal affairs, statistics, pest control. Field offices El-Arish, Bir El-Abd, El-Hasana, Nakhl, Sheikh Zuwayid, Rafah, 100 staff.
- Agricultural Extension Service	10 feddan demonstration farm: vegetables, seeds, nurseries. Approves fertilizer requests. Supervises pest control.
- Animal Production Dept.	Construction, management of poultry farms and livestock feed lots.
- Green Revolution Authority	Drills wells, provides technical assistance, distributes seedlings, 200 staff in El-Arish.
- Principal Bank for Development and Agricultural Credit(PBDAC)	Loans for livestock, poultry, and fishing operations, tractors and trucks: warehousing; distribution of fertilizers; main maintenance of irrigation systems.
Akkaria Company	Operates Hero Viollage reclamation site.
Arab Contractors	Operates New Mit Abul Kom reclamation site.
Governorate of Ismailia	Supports the Youth Farms in East Bitter Lakes.
ISMAMEX	Exports fruit and vegetables from Ismailia Governorate; branch at Sarabium.

6.21. Enterprise Budget on Pepper----El-Arish, 1981

Yield (ton)	6.0
Price (£E/kg)	0.23
Gross return (£E)	1,380.0
Variable cost (£E)	
Land preparation	50.0
Seeds	30.0
Chemical fertilizer	25.0
Manure	82.0
Pesticides	20.0
Transport of product	60.0
Water	43.0
Labour	585.0
Total	895.0
Fixed cost (£E)	
Depreciation	52.0
Land	61.0
Interest	24.0
Total	137.0
Return to management and capital (£E)	348.0
Net farm income (£E)	933.0

Note: Estimated that peppers are on the field 9 months.

6.22. Enterprise Budget on Date Palm----El-Arish, 1981

Trees (no./feddan)	85
Non-producing trees (no./feddan)	8
Producing trees (no./feddan)	77
Yield (kg/tree)	125.0
Price (£E/kg)	0.12
Gross revenue (dates only)	1,155.0
Byproducts	
Palm leaves (no./tree)	10.0
Price (£E/leaf)	0.04
Gross revenue (leaves)	31.0
Palm branches (no./tree)	5.0
Price (£E/branch)	0.25
Gross revenue (branches)	96.0
Total	1,282.0
Variable cost	
Fertilizer	220.0
Fertilization labour	43.0
Harvest labour	153.0
Total	416.0
Return to management, land	866.0
Net farm income	1,062.0

6.23. Enterprise Budget on Okra----El-Arish, 1981

Yield (ton)	5.0
Price (£E/kg)	0.22
Gross return (£E)	1,100.0
Variable cost (£E)	
Land preparation	50.0
Seeds	5.0
Chemical fertilizer	25.0
Manure	73.0
Pesticides	25.0
Transport of product	50.0
Water	38.0
Labour	786.0
Total	786.0
Fixed cost (£E)	
Depreciation	46.0
Land	54.0
Interest	18.0
Total	118.0
Return to management and capital (£E)	196.0
Net farm income (£E)	716.0

Note: Estimated that okra is on the field 8 months.

6.24. Agricultural Benefits Derivable from Crop Production and Livestock Rearing

1) Revenue and Expenditure of Typical Farm Budget

The financial analysis of the project area was made from the farmers' viewpoint. In order to estimate the farm budget under the future with project conditions, the analysis was made on 12-feddan unit farm.

After the irrigation development, the annual gross return in farm production by farmers is expected to increase in unit yield of various crops and in amount of livestock products year by year. The return will be at its maximum starting from the seventh year and onwards after irrigation development is completed. Annual gross return from crop production and livestock rearing in and after the seventh year of irrigation development applying intensive farming system is estimated at £E8,596 per farm household on an average.

On respective farms, advanced farming practices will be introduced for profitable farm management. Accordingly, the fund necessary for the performance on such farm activities will necessarily be more when compared to those for primitive methods. The farming expenditure increases with the advanced farming and is at a maximum in and after the seventh year 1/.

1/ : There is no standard definition of marginality. The most frequently qioted definition is 'when output equals input', but the terms 'input' can be interpreted in many years. The World Bank defines marginality as the point when annual returns from crops cover annual costs.

According to the current Ministry of Land Reclamation estimates the maximum preparation period for land under reclamtion is ten years or five yers for calcareous soils, seven years for clay and ten years for sandy soils. After these periods, the land should be approaching its highest level of productivity. In this study, in due consideration of utilizing treatment plant effluent as well as soil conditions, it is assumed that after seven years the land will be approaching its gighest level of productivity.

2) Assumption for Calculating Typical Farm Budget

(1) Inputs and Outputs Prices

Inputs and outputs financial prices at farm were applied to calculating the net agricultural income. Present retail prices were utilized for input goods such as fertilizer and agro-chemicals and present farm gate prices were utilized for output goods such as agricultural products and livestock rearing.

(2) Labour Costs

The hired labour cost was estimated at the labour costs. Amount of hired labour means the total of the labour requirements over the available family labour force in each month. Seven Egyptian Pounds per man-day was used as the wage rate.

(3) Time of Comparison

Input, output and labour cost are applied to the typical farms at Present, Without Project and With Project.

(4) Project Charge

For the typical farm with Project, ability to pay was calculated in regard to repayment of on-farm development costs and expenditures for operation and maintenance costs. The annual project charge for farmers was estimated on the assumption as below.

a. All of typical farm benefit area is located in the intensive development area.

b. The on-farm development costs liable to repayment by beneficiary is ten per cent of public facilities cost. The terms of repayment grace are that i) the rate of compound interest is 12 per cent per annum, ii) period is three years after the project completion and iii) repayment is made installment for 15 years.

Ability to pay which is calculated by deducting labour costs from actual net return can be estimated at £E4,670.8. From the ability to pay, the farmer must pay the annual O & M costs. According to the calculation, the O & M costs are estimated at £E436 per farm household. Therefore, about £E4,235 of net profit will be reserved even after payment of O & M costs. The typical farm budget is shown in Table

Typical Farm Budget of 12-Feddan Unit Farm in and after the Seventh Year of Project Completion - Financial -

Crop Production

Crop	Cropped Acreage (fd)	Unit Yield (ton/fd)	Unit Price (£E/ton)	Gross Value (£E/ Unit farm)	Pro-duction Cost (£E/ Unit farm)	Net Value (£E/ Unit farm)
Winter						
Berseem 1/	1.2	-	-	-	-	-
Barley	1.2	1.4	70	117.6	51	66.6
Potatoes	0.6	7.6	110	501.6	287	214.6
Broad beans	1.2	1.3	85	132.6	75	57.6
Summer						
Okra	0.6	4.8	200	576	273	303
Watermelon	2.4	14.5	50	1,740	943	797
Green pepper	1.2	7.0	25	210	115	95
Perennial						
Citrus	1.2	3.5	130	546	262	284
Olive 2/	3.6	-	-	3,240	1,080	2,160
Alfalfa 3/	1.2	-	-	-	-	-
Sub-total	12.0			7,063.8		3,977.8

(Cropping intensity: 120 %)

Livestock Production

Livestock		Gross Value (£E/Unit farm)	Net Value (£E/Unit farm)
Goats			150
Sheep			200
Chicken	Chicken		250
	Eggs		540
Sub-total		1,924	1,140
Total			5,117.8
Labour cost			447
Grand Total			4,670.8

1/ and 3/ : Utilized as feed. 2/ : Assuming that oils are utilized.

6.25 Economic Evaluation

1) General

The economy of the Jarada Agricultural Development area is less developed compared to major parts of the El-Arish valley, and the development of the area is given priority by the Governorate of North Sinai, in line with the emphasis currently on integrated and agricultural development utilizing treatment plant effluent.

The Project is intending to develop more than 600 feddans of the farm land for the stabilization of the agricultural production, the creation of the employment opportunities and the improvement of the living environment for a higher living standard of farmers. To achieve the object, the construction of irrigation schemes and related facilities is required. Construction work of the Project consists of a main pump to be attached to a storage tank of the proposed sewerage treatment plant, main and secondary pipelines, on-farm facilities and others. The investment for the Project is considered to be justifiable in terms of the net value added to the regional economy, the benefits to farm families and other socio-economic benefits.

2) Economic justification

Economic costs: The economic costs of the Project including sewerage systems are estimated at £E53,169,000 at mid-1984 prices which include the total investment cost except for the allowance for land acquisition, taxes and duties and price escalation. Operation and maintenance costs are calculated separately.

Economic benefits: Besides benefits derivable from the proposed sewerage systems, the major direct benefits to evolve from the Jarada Agricultural Development Project will be substantial increase in agricultural production and the resulting in the increased income and employment opportunities. The agricultural benefits are the major direct benefits derived from the Project. The agricultural benefits attributable to the Project are mainly in the form of incremental agricultural production less incremental costs, both of which are calculated on the basis of economic value from the view point of regional economy.

The increase in agricultural production will be mainly due to i) increase in cropping intensity from about 10 per cent without the Project to 120 per cent with the Project at full development; ii) higher annual average yields of various crops to be introduced in the farm land; and iii) application of multi-cropping systems.

The Project will, when fully developed, generate agricultural incremental net benefits of £E232,000 per year. The annual agricultural bebefits and related data are shown in the attached paper.

Summary of Construction Cost

(Experimental Farm)

(£E'000)

Item	Foreign	Local	Total
Pumps	12	2	14
Pipelines	10	3	13
Civil work	40	64	104
Equipment for experiment	204	25	229
Engineering service	186	0	186
Sub-total	452	94	546
Contingencies 1/	55	17	72
Total	507	111	618

1/ : Physical and price contingencies.

Summary of Construction Cost

(Agricultural Development)

(£E'000)

Item	Foreign	Local	Total
Pumps	72	12	84
Pipelines	206	46	252
Civil work	129	182	311
Supporting work	99	37	136
Engineering service	225	0	225
Sub-total	731	277	1,008
Contingencies 1/	123	113	236
Total	854	390	1,244

1/ : Physical and price contingencies.

Typical Farm Budget of 12 Feddan Unit Farm in and after the Seventh Year of Project Completion. - Economic -

Crop Production

Crop	Cropped Acreage	Unit Yield	Unit Price	Gross Value	Pro-duction Cost	Net Value
	(fd)	(ton/fd)	(£E/ton)	(£E/ Unit farm)	(£E/ Unit farm)	(£E/ Unit farm)
Winter						
Berseem 1/	1.2	-	-	-	-	-
Barley	1.2	1.4	71	119.3	50	69.3
Potatoes	0.6	7.6	111	506.2	281	225.2
Broad beans	1.2	1.3	86	134.2	74	60.2
Summer						
Okra	0.6	4.8	202	581.8	268	313.8
Watermelon	2.4	14.5	51	1,774.8	924	850.8
Green pepper	1.2	7.0	26	218.4	113	105.4
Perennial						
Citrus	1.2	3.5	132	554.4	257	297.4
Olive 2/	3.6			3,255	1,074	2,181
Alfalfa 3/	1.2					
Sub-total				7,144.1		4,103.1

(Cropping intensity: 120 %)

Livestock Production

Kind		Gross Value (£E/Unit farm)	Net Value (£E/Unit farm)
Goats			153
Sheep			204
Chicken	Chicken		255
	Eggs		551
Sub-total			1,163
Total			5,266.1
Labour cost			431
Grand Total			4,835.1

1/ and 3/ : Utilized as feed. 2/ : Estimated assuming that oils are utilized.

Income with and without the Project

- Economic -

(Unit: £E)

No.	Year	Present Income	Without Project Income (A)	With Project: Income from Crops (B)	With Project: Income from Fruits (C)	With Project: Income from Livestock (D)	Total (E) =(A+B+C+D)	Difference (F) =(E-A)
1		0	0	-	-	-	-	-
2		0	0	46,032	-	38,880	84,912	84,912
3		0	0	52,416	-	42,528	94,944	94,944
4		0	0	57,360	-	45,696	103,056	103,056
5		0	0	61,584	-	48,816	110,400	110,400
6		0	0	63,744	-	52,512	116,256	116,256
7		0	0	70,800	54,385	52,512	177,696	177,696
8		0	0	70,800	80,496	52,512	203,808	203,808
9		0	0	70,800	88,000	52,512	211,312	211,312
10		0	0	70,800	94,608	52,512	217,920	217,920
11		0	0	70,800	101,136	52,512	224,448	224,448
12		0	0	70,800	108,768	52,512	232,080	232,080
13		0	0	70,800	108,768	52,512	232,080	232,080
14		0	0	70,800	108,768	52,512	232,080	232,080
15		0	0	70,800	108,768	52,512	232,080	232,080
↓		↓	↓	↓	↓	↓	↓	↓
50		0	0	70,800	108,768	52,512	232,080	232,080

1/: The 1st year means the year when crop cultivation is commenced.

Summary of Economic Benefit and Cost of the Project

(including agricultural development)

(£E'000)

Year No.	Benefit	Cost 1/	Net Flow (Incremental Cost)	Present Worth Discounted at 9%	Present Worth Discounted at 10%
1.	-	1,095	-1,095	-1,004	-995
2.	85	3,337	-3,252	-2,737	-2,687
3.	95	4,273	-4,178	-3,226	-3,139
4.	103	5,503	-5,400	-3,825	-3,688
5.	110	5,306	-5,196	-3,377	-3,226
6.	116	4,596	-4,480	-2,671	-2,932
7.	1,035	2,677	-1,642	-898	-843
8.	1,282	2,693	-1,411	-708	-658
9.	1,489	2,554	-1,065	-490	-452
10.	1,799	2,180	-381	-161	-147
11.	2,115	2,324	-211	-82	-74
12.	2,456	2,587	-131	-47	-42
13.	2,542	2,596	-54	-18	-16
14.	2,945	1,791	1,152	345	503
15.	3,401	1,415	1,986	545	475
16.	3,968	1,428	2,540	640	553
17.	4,715	1,482	3,233	747	639
18.	5,446	1,307	4,139	877	745
19.	6,272	1,324	4,948	962	809
20.	7,425	1,341	6,084	1,086	904
21.	8,548	1,360	7,188	1,177	971
↓	↓	↓	↓	↓	↓
50.	8,548	6	8,542	115	73
Total	303,837				

$$E\,I\,R\,R = 9\,\% + \frac{1,146}{1,146 + 2,022} = 9\,\% + 0.36\,\% = 9.36\,\%$$

1/ Including O & M cost.

Remarks: 1. All in constant prices at mid-1984.
2. Price escalation was excluded.

6.26. Necessity for Further Agricultural Study

It is well known that agriculture in the El-Arish area is the most important economic sector, and in recent years, accounts for almost 30 per cent of the Gross Domestic Product. And 40 per cent of the labour forces in the El-Arish area is engaged in or dependent on farming and related activities.

In the existing farm land of the El-Arish area, various crops such as olive, dates, watermelon, cucumber, corn, tomatoes and others are harvested annually. Nevertheless, the total output lags behind the rate of population growth.

In order to increase the output, the Governorate of North Sinai is newly planning to promote the agricultural development utilizing treatment plant effluent, besides the development of the existing agriculture. In accordance with the Governorate's policy, an agricultural development has been planned in the land of about 600 feddans extending within the Jarada area.

In accordance with the agreement between the Government of Japan and Arab Republic of Egypt entered into force on 31st January, 1984, a feasibility study on the El-Arish Sewerage and Drainage System was carried out during the period of July, 1984 to February, 1985. On the basis of the feasibility study, this report was prepared in March, 1985.

In this feasibility study, with regards to the sewerage and drainage system and the experimental farm for the reuse of treatment plant effluent, a study of the feasibility study level was carried out, but as for the agricultural development for the Jarada area, only a study of the preliminary level was conducted in accordance with the agreement mentioned above. For the desirable realization of the sewerage and drainage system project in the El-Arish area, further detailed studies for the Jarada area are required. From the viewpoint of the above, the following will be proposed.

TERMS OF REFERENCE FOR FURTHER AGRICULTURAL STUDIES

I Objective and Scope

The objective of the proposed further agricultural studies is to prepare a comprehensive feasibility study on the agricultural development in the Jarada area utilizing treatment plant effluent. The feasibility study will examine the technical, economic, financial and institutional aspects of the project in sufficient detail to allow investment decisions by the Governorate of North Sinai, Arab Republic of Egypt and donor agencies. This study will be carried out in two steps: (i) surveys and investigations and preparations of agricultural development plan utilizing treatment plant effluent; and (ii) preparation of detailed feasibility study in due consideration of the Feasibility Report "EL-ARISH SEWERAGE AND DRAINAGE SYSTEM IN THE NORTH SINAI PROVINCE, ARAB REPUBLIC OF EGYPT" prepared by Japan International Cooperation Agency (JICA) in March, 1985.

II Terms of Reference

Consultants will prepare a comprehensive agricultural development plan utilizing treatment plant effluent for the project area, and carry out a project feasibility study with the assistance of Governorate counterparts in accordance with, but not limited to the following:

A. Review of Existing Data, Surveys and Reports

In carrying out the further agricultural studies, review all previous engineering, agricultural, economic and socio-economic studies, in particular, the agricultural development programme of the Egyptian Government as stipulated in the 6th Year Development Plan and related policy issues with respect to: (i) role of irrigation water delivery system, especially drip irrigation system; (ii) groundwater resources development; (iii) utilization of treatment plant effluent; (iv) quality control of treatment plant effluent; (v) forecast of treatment plant effluent quantity; (vi) procurement of irrigation equipment; (vii) supply of spare parts and services; (viii) role of farmers' cooperatives; (ix) arrangements for operation and maintenance; (x) others.

B. Preparation of Project Feasibility Study

Based on the findings and recommendations prepared in the 1st step, prepare a detailed feasibility study of the project in accordance with the following items:

1. Irrigation and Drainage
2. Agricultural Supporting Services
3. Socio-Economic Problems
4. Environmental Problems
5. Project Cost
6. Economic Evaluation and Financial Analysis

6.27. Adaptable Crops for Plant Effluent

With regards to selection of suitable crops on the basis of law and decrees concerned, its outline was described in 6.6. of APPENDIX - SIX. As seen in the paragraph, selected kind of crops are as follows:

Winter crops	:	berseem, barley, potatoes and broad beans
Summer crops	:	okra, watermelon and green pepper
Perennial crops	:	citrus, olive and alfalfa

In the meantime, plant effluent often contains much higher levels of nitrogen than do normal sources, therefore special consideration must be given to the detrimental effects of excessive nitrogen on both the crop and the environment.

In view of the above, in the proposed Jarada farm land where water quality of the plant effluent might be limited, especially in nitrogen content, the use of plant effluent can greatly influence the selection of kind of crops.

As seen in 6.12. 'Management Alternatives for Irrigation Water High in Nitrogen', APPENDIX - SIX, when excessive quantities of nitrogen are contained in plant effluent, necessary countermeasures must be taken for the success of the crop cultivation. One of the countermeasures is application of nitrogen non-sensitive crops rather than sensitive crops.

Compared to salt tolerance, data on sensitivity of crops to nitrogen are not so available. In general, vegetables and cereal crops are sensitive and forage crops are non-sensitive as far as grasses are utilized as feed.

APPENDIX-SEVEN

LAW NO. 48/1982: PROTECTION OF THE RIVER NILE AND WATER COURSE FOR SPORTS (EXCERPT)

APPENDIX - SEVEN

LAW NO.48/1982: PROTECTION OF THE RIVER NILE AND WATER COURSE FOR SPORTS (Excerpt)

Chapter 6 Controls, Criteria and Specifications of the Treated Liquid Waste Drained Drained into Water Courses.

First: Drainage into fresh water surfaces

Item 60: The fresh water surfaces where treated liquid wastes are allowed to be drained should have the following criteria and specifications;

Item	Criteria and Specifications unless otherwise specified (mg/l)	
Colour	Not more than 100 degrees	
Total solid materials	500	
Temperature	5°C above normal	
Dissolved oxygen	not less than 5	
pH	not less than 7 and not more than 8.5	
Active absorbent oxygen	not more than 6	
Consumed chemical oxygen	"	10
Organic nitrogen	"	1
Ammonia	"	5
Grease and oil	"	0.1
Total alkaline	"	150 and not less than 20
Sulphats	"	200
Mercury compounds	"	0.001
Iron	"	1
Manganese	"	0.5
Copper	"	1
Zinc	"	1
Artificial detargents	"	0.5
Nitrates	"	45
Florideac	"	0.5
Phenol	"	0.02
Arsenic	"	0.05
Cadmium	"	0.01
Chrome	"	0.05

(To be continued)

Item	Criteria and Specifications, unless otherwise specified in mg/l.
Lead	note more than 0.05
Splenium (?)	" 0.01

Item	Maximum of Industrial Waste Types Treated to be Drained into ;	
	The River Nile from the southern border to the . Delta Barrages	The Nile branches, feedres, sub-canals and underground water reservoir
Active absorbent oxygen	40	30
(Dicromant) The chemically consumed oxygen	60	40
(Permanganates) The chemically consumed oxygen	20	15
Total of solid materials	1,500	1,000
Cinders of solid materials	1,000	900
Parasites	40	30
Grease, oil, etc.	10	10
Nitrates	40	30
Phenol	0.005	0.002

Item 61: Criteria for permission to drain treated liquid wastes into the fresh water surfaces and underground water reservoirs as pronounced by the Ministry of Health (All units are in mg/l unless otherwise specified).

Item	Maximum Criteria for Treated Industrial Liquid Wastes to be Drained Into;	
	The River Nile from the southern border of Egypt to the . Delta Barrages	The Nile branches, feedres, subcanals , and underground reservoirs
Temperature	30°C	35°C
pH	6 - 9	6 - 9
Colour	free from colouringmaterial	
Active Absorbent Oxygen	30	20

(To be continued)

(Cont'd)

Item		
(Dicromat)Consumed oxygen	40	30
(Permanganates) Consumed Oxygen	15	10
Total of Dissolved Solids	1,200	800
Cinders of Dissolved Solids	1,100	700
Parasites	30	30
Cinders of Parasites	20	20
Sulphates	1	1
Grease, Oils, etc.	5	5
Phosphate(Nonorganic)	1	1
Phenol	0.002	0.001
Florideae	0.5	0.5
Remaining Chlorine	1	1
Total of Heavy Metals	1	1
Mercury	0.001	0.001
Lead	0.05	0.05
Cadomium	0.01	0.05
Arsenic	0.05	0.05
Sexivalent Chrome	0.05	0.05
Copper	1	1
Nickel	0.1	0.1
Iron	1	1
Manganese	0.5	0.5
Zinc	1	1
Silver	0.05	0.05
Artificial Detargents	0.05	0.05
Probable calculation of the Colone Group 100 cm^3	2,500	2,500

Terminology indicated above is taken from the English version translated from original Arabic version.

Item 62: Without breach to the essence of Item 60 of this prospectus, the Ministry of Irrigation is authorized to overlook some of the above-mentioned criteria (specifications). This must not take place unless the industrial liquid waste materials to be drained after treatment is less than 100 m^3/day and should be within the following limits: (Note; the same table in Item 60 in addition to the following items.)

Item	Criteria (mg/l)
Smell (Scent)	2 degree (Cold)
Tannin and Lignin	0.5
Phosphate	1
Extracts of carbon-chlorform	1.5
Probable count of the colone group 100 cm^3	5,000

Second: Drainage into non fresh water surfaces.

<u>Item 66:</u>

Item	Maximum of Criteria and Specifications in mg/l unless otherwise specified.	
	Sewage	Industrial liquid wastes
Temperature	35°C	35°C
pH	6 - 9	6 - 9
Active absorbent oxygen	60	60
Consumed chemical oxygen (Micromant)	80	100
" (Permanganates)	40	50
Dissolved oxygen	not less than 4	
Grease and oils	10	10
Parasites	50	60
Colouring material	none	none
Dissolved substances	2,000	2,000
Sulphates	1	1
Sianade	-	0.01
Phosphate	-	10
Nitrates	50	40
Florideae	-	0.5
Phenol	-	0.005
Total of heavy metals	1	1
Probable count of clone group in 100 cm^3	5,000	

APPENDIX-EIGHT

PROJECT ORGANIZATION

APPENDIX - EIGHT

PROJECT ORGANIZATION

1. Government of Egypt

The Government of Egypt provided through the North Sinai Governorate (NSG) the necessary counterpart staff to the Japanese study team throughout the period for the study at the project site. At the beginning of the study work, the following government personnel were attached to the Project:

Eng. Ibrahim Kalaf	General Manager of Housing Dept.
Eng. Mohamed El Sherief	Secretary of Housing Dept.
Eng. Salem Abd El Hady	El-Arish City Council
Eng. Said El Sherief	NSG
Eng. Abd El Magied Nassier Selmi	Housing Dept.
Eng. Hamdy El Sherief	Information Management NSG
Eng. Hassan Shabaan	Housing Dept.
Mr. Magdy Gamal Serry	Planning Statistics Office NSG
Eng. Gomma Abbas	Housing Dept.
Eng. Mohammed Nassar	Agricultural Dept.
Dr. Wahby Abdallah	NSG

In addition to the above personnel, many other supporting staff from the various agencies have participated the Study and assisted the study team in efficient and smooth undertaking of the study work throughout the study period.

2. JICA Study Team

The JICA study team comprises the following personnel of Nihon Suido Consultants Co., Ltd:

Mr. Shohei Sata	Team Leader, responsible for over-all control of the progress of work and liaison between the governments of Egypt and the study team. Also, responsible for the study on city planning of the study area.
Mr. Gakuji Kimura	Agricultural Expert, responsible for planning of agricultural programme, particularly of the treated sewage reuse for crop irrigation.
Mr. Masaaki O'Hashi	Economist, responsible for developing financial and economic planning of the project.
Mr. Junichi Yamashita	Sewerage Engineer, mainly in charge of sewage treatment plant planning and design.
Mr. Yasushi Hirau	Sewerage Engineer, in charge of sanitary and storm sewer system planning and design.
Mr. Hajime Sakurai	Sewerage Engineer, responsible for sewerage planning and cost estimates.
Mr. Ikuo Tanaka	Sewerage Engineer, responsible for sanitary and storm sewerage planning and design.
Mr. Kazuo Inoue	Sewerage Engineer, responsible for planning and design of sewage treatment plant.
Mr. Kazuo Ikeda	Mechanical/Electrical Engineer, responsible for planning and design of mechanical and electrical equipment for the sewage treatment plant.
Mr. Akio Kasai	Biochemist, responsible for water quality and quantity survey.

3. Advisory Committee

The Committee comprises the following personnel:

Dr. Hideo Fujii	Chairman, responsible for advising and guiding the study team members for sewarage and drainage plan-

ning and design.
Executive Director, Headquarters on Research and Training, Japan Sewage Works Agency.

Mr. Ichiro Seto	Adviser for city planning and drainage system of the project. Assistant Director, River Basin Sewerage Sewerage Division, Sewerage and Sewage Purification Department, City Bureau, Ministry of Construction.
Mr. Yasuo Hoshikuma	Adviser for water quality and treated sewage reuse plan. Chief, Sewage Works Division, Water Quality Control Department, Public Works Research Institute, Ministry of Construction.
Mr. Takashi Yamazaki	Adviser for sewerage system planning. Deputy Chief, the Designing Department, Sewage Works Bureau. The City of Yokohama.
Mr. Nobuo Kimura	Project Coordinator. Deputy Head, Second Development Survey Division, Social Development Cooperation Department, Japan International Cooperation Agency.

ORGANIZATION FOR FEASIBILITY STUDY