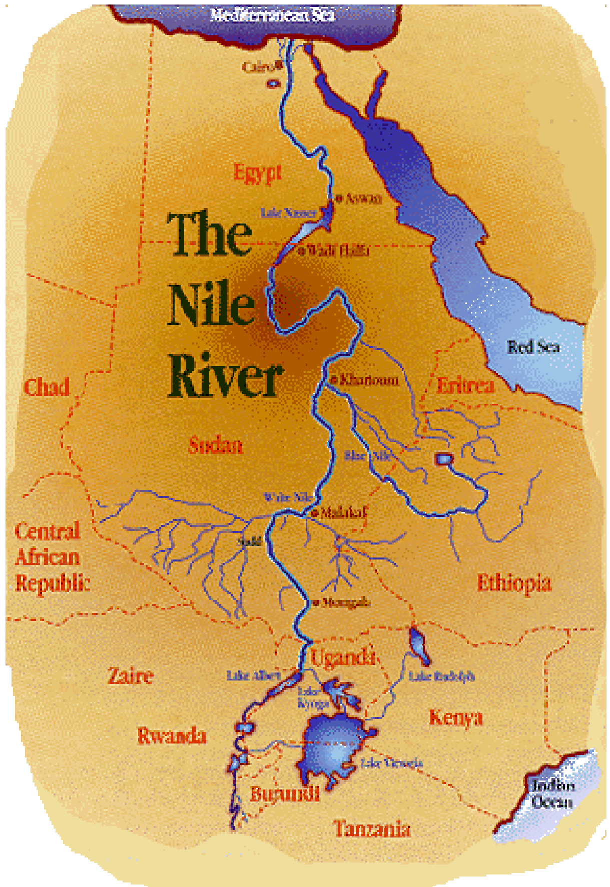
Nile Basin Initiative
Nile Trans boundary Environmental Action Project

Nile Basin National Water Quality Monitoring Baseline Study Report

for

Egypt

August
2005


Mediterranean Sea
Cairo
Egypt
Aswan
Lake Nasser
The Nile River
Red Sea
Khartoum
Eritrea
Chad
Sudan
Blue Nile
White Nile
Malakal
Central African Republic
Ethiopia
Uganda
Zaire
Lake Albert
Lake Kyoga
Lake Rudolph
Kenya
Rwanda
Lake Victoria
Burundi
Tanzania
Indian Ocean

Nile Water

River Nile is the second longest river in the world with 6700 km long and catchment's area of about 2,900,000 km^2 which covers nine riparian countries that are Uganda, Kenya, Tanzania, Rwanda, Burundi, Zaire, Ethiopia, Sudan and Egypt. It flows northwards from its source in the south near Lake Tanganika to discharge into the Mediterranean Sea.
The sources of Egyptian Nile water supplies are in the Ethiopian (83%) and Equatorial Plateaus (17%). The yield of the former can be divided as follows: 13%, 58% and 12% from Subat, Blue Nile and Otbara River, respectively. In case of the latter, it is amazing that of its huge resources about 110 BCM /year reach the Victoria Nile branch. The rest is mainly lost by evaporation. The total amount of water collected south of Sudan (33 BCM /year) spreads over the giant 700 km^2 swamps. These swamps receive water from Bahr-El-Ghazal as well as from Bahr- Al-Arab. The former is extended over more than 160 km to Lake Nu. The output to the White Nile is only 15 x 10^9 m^3 /year. That is why the construction of Gunglie Canal can ensure the supply of Egypt as well as North Sudan in an amount of a few milliard m^3 of water originally lost by evaporation along the big distance. Hence, the cooperation between the Nile Valley countries is essential to protect such a vital source of water (Hagras, 1988; Said, 1993).
The calculated average flow of Nile in the period 1900-1959 was 84 x 10^9 m^3/ year at Aswan. After subtracting 10 BCM/ year as average annual evaporation and other losses (El-Khodari, 2003), the net usable annual flow is 74 BCM/ year. According to the agreement signed in 1959 between Egypt and Sudan, the water budget from River Nile is 18.5 BCM to Sudan and 55.5 BCM to Egypt (Dijkman. 1993). Internal surface water resources are estimated at 0.5 x 10^9 m^3 / year. This comes up to 56.0 x 10^9 m^3 / year as a total. Nile water comprises about 97% of the renewable water supplies in Egypt, thus it is believed that River Nile is the sole source of life.
The Nile is at present the only major river in the world which is totally controlled and fully utilized. This was achieved by an extensive Egyptian-Sudanese River Programme, which included six dams, the Jonglei Canal, seven barrages, and the Aswan High Dam.
The Nile River enters Egypt at its southern boundary with Sudan and runs through a 1000 km long narrow valley which varies between 2 and 20 km in width. Then it is divided at a distance of 25 km north of Cairo into the two branches (Rosetta and Damietta) forming a delta resting with its base on the Mediterranean Sea shore. The delta extends from south to north about 200 km and its base is about 300 km long from Alexandria to Port-Said. Water is diverted and supplied to the inhabited

areas by means of control structures and a system of man-made network of canals.

In view of the increasing population from 20 millions in 1952 to 38 millions in 1977 to 61,4525 millions in 1996 (about 63 millions in 1999), the availability of water has been a determining factor between prosperity and famine in Egypt when the Nile yield has been subjected to dramatic changes from year to another. The population growth and rising living standards have put more stress on both land and water resources. Increased industrial growth together with intensified agriculture also has a direct impact on surface as well as groundwater quality. Availability of water is also constrained by its degraded quality which limits its use for specific purposes.

The following map showed the Egyptian Nile Valley (the deep color part).

Rashid
Damietta
Mediterranean
Port Said
Kafr El Sheikh
Alexandria
Mansoura
Tanta
Zagazig
Bubastis
Wadi
Natroun
Giza
Cairo
Helwan
Suez
Sinai
El Fayoum
Beni Suef
Minia
Beni Hassan
Hermopolis
El Amarna
Red
Sea
Egypts
Eastern
Desert
Assuit
Egypts
Western
Desert
Sohag
Abydos
Dendara
Qena
Qift
Qus
Luxor
Kharga
Oasis
Esna
El Kab
Edfu
Kom
Ombo
Kalabsha
Aswan
Lake
Nasser
Meharakka
Toshka
Abu Simbel
Kasr Ibrim
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Water Resources in Egypt

A. Conventional Resources

The conventional water resources in Egypt are limited to the Nile River, ground water in the Delta, Western deserts and Sinai, rainfall and flash floods. Each resource has its limitations on use. These limitations relate to quantity, quality, location, time, and cost of development.

1. Nile Water

Egypt is an arid country which depends almost entirely on the River Nile for its water supply. It is estimated that the Nile River provides about 97% of the country's fresh renewable water supply. Agriculture is almost totally dependent on this source. It is estimated that 85 percent of the water released from the High Aswan Dam is using for irrigation with the remaining 15 percent for other purposes, i.e., industry, domestic water supply, navigation, hydropower, fisheries, recreation and tourism. Table 1 demonstrates the water supplies and demands in Egypt between year 1990 and 2025.

The overall country water balance is considered not well established due to unreliable data on both the supply and demand in the system. Earlier studies have noted that during normal flow, shortages of 26 percent of the total water requirement could occur and could reach 2227 percent in extreme shortages. Some estimates have suggested that the per capita share of fresh water will drop to 350 m^3/ yr from the current 1000 m^3/ yr by 2025.

To increase the supply of water resources, the government is examining agricultural reuse of drainage water; reuse of treated municipal water; and improving irrigation efficiency.

Water demand management is a relatively new concept in Egypt and much of the world. The GOE has recognized the importance of demand management to maximize the benefits of available water resources. Public awareness is view as essential.

Water conservation and demand management are also viewed as key in municipal and industrial sectors.

Table 1: Water supplies and demands in Egypt
(10^9 m^3 /year)

Water supplies & demands	1990	2000	2025
I. Water supplies			
Nile water	55.5	57.5*	57.5*
Groundwater:			
In the Delta and New Valley	2.6	5.1	6.3
In the desert	0.5		
Reuse of agricultural drainage water	4.7	7.0	8.0
Treated sewage	0.2	1.1	2.4
Management and saving wastewater	-	1.0	-
Total	63.5	71.7	74.2
II. Water demands			
Agriculture	49.7	59.9	61.5
Households	3.1	3.1	5.1
Industry	4.6	6.1	8.6
Navigation	1.8	0.3	0.4
Total	59.2	69.4	75.6

* After the Gungli Canal
Data based on Abdel-Dayem (1994) and El- Kassas (1998).

2. Groundwater

Groundwater exists in the western desert within the Nubian sandstone aquifer that extends below the vast area of the New Valley's Oasis and its sub-region East of Owaynat. This aquifer stores about 200,000 BCM of fresh water. However, this ground water occurs at great depths and the aquifer is generally non-renewable. Therefore, the utilization of such water depends on pumping costs and its depletion versus the potential economic return over the long run.
Groundwater in Sinai exists mainly in three different water-bearing formations; the shallow aquifers in Northern Sinai; the valley aquifers; and the deep aquifers. The shallow aquifers in the Northern part of Sinai are composed of sand dunes that hold the seasonal rainfall, which

helps in fixing these dunes. The aquifers in the coastal area are subjected to salt-water intrusion. The total dissolved solids in this water range from 2,000 to 9,000 ppm.

The groundwater aquifer underlying the Nile valley and Delta is recharged by seepage losses from the Nile, the irrigation canals and drains, and deep percolation of water from irrigated lands. The total available storage of the Nile aquifer is estimated at about 500 BCM but the maximum renewable amount (the aquifer safe yield) is around 7.5 BCM. The existing rate of groundwater abstraction in the Valley and Delta regions is about 4.8 BCM/ year, which is still below the potential safe yield of the aquifer.

The quality of groundwater is so far evaluated on an intermittent basis, predicting signs of pollution within a 30 meter depth (abdel-Dayem, 1994).

3. Rainwater

Rainfall on the western Mediterranean coastal strip (from Alexandria city to El-Sallum) decreases eastward from 200 mm/ year at Alexandria to 75 mm/year at Port Said. The northern coast receives a modern amount of water rainfalls with a mean level of 150 mm/yr. It diminishes to 100 mm/yr to the east in El-Arish region then rises up again to 250 mm/yr eastern of El-Arish at Rafah, northern Sinai. The water available is merely sufficient for pastoral purposes, to some extent for seasonal agriculture (barley) especially in excessively rainy years, for cultivating some Olive and Fig in the western and Peach in the eastern zones.

It also declines inland to about 25 mm/year near Cairo. Rainfall occurs only in the winter season in the form of scattered showers. Therefore, it cannot be considered a dependable source of water.

Coastal sand dunes and valley sediments that receive rainfall accommodate shallow wells for drinking water. In Sinai, some reservoirs have been constructed to collect heavy rainfalls in the valleys.

B. Non-Conventional Water Resources

This includes agricultural drainage water, treated wastewater, and desalinization of seawater. Each resource has its limitation on use. These limitations relate to quantity, quality, space, time, and/or cost of use. These water sources cannot be considered independent resources and cannot be added to Egypt’s fresh water resources. In fact using these sources is a recycling process of the previous used fresh Nile water in a way that improves the overall efficiency of the system for water distribution. These types of sources should be used and managed

with care, and their environmental and health impacts must be evaluated carefully.
Non-conventional water resources represent approximately 6.5 % of the total supply, the major share being the drainage water with 4 – 4.5 x 10^9 m^3/ year and the others; treated wastewater reuse and desalinated water. These sources are estimated at 200 x 10^6 m^3 / year and 25 x 10^6 m^3/ year, respectively.

1. Drainage Water Reuse

Reuse of agricultural drainage water has been practiced for many years to cover the shortage in surface fresh water needed for the expansions in agricultural area in order to cover the increase in demands for food for the increase in population. The agricultural drainage of the southern part of Egypt returns directly to the Nile River where it is mixed with the Nile fresh water and reused for different purposes downstream.
The total amount of such indirect reuse is estimated as 4.07 BCM/year in 1995/96. This drainage flow comes from three sources; tail end discharges and seepage losses from canals; surface runoff from irrigated fields; and deep percolation from irrigated fields. The first two sources of drainage water are of relatively accepted quality. The deep percolation component is highly saline, especially in the northern part of Delta, due to seawater intrusion and upward seepage of groundwater to drains.
In addition, it is estimated that some 0.65 BCM/year of drainage water is pumped to El-Ibrahimia and Bahr Yousef canals for further reuse. Another 0.235 BCM/year of drainage water is reused in Fayoum while about 0.65 BCM/year of Fayoum drainage is disposed of in Lake Qaroun.
Reuse of agricultural drainage water in the Delta is limited by water salinity which increases by moving from upstream to downstream. In most of the valley and in the southern part of the Delta region, the salinity remains below the critical level of 1,000 ppm which is suitable for reuse. However, in the northern part of Delta region, large quantities of salt water (2.0 BCM/year) seep through groundwater to the drainage water due to the sea water intrusion. This water is pumped back to the sea and northern lakes to maintain the salt balance of the system. The amount of agricultural drainage water reuse was estimated in 1995/96 as around 4.27 BCM in addition to about 0.3 BCM lifted to Rosetta branch from the west delta drains. This constitutes the official reuse carried out by pumping stations of the Ministry of Irrigation and Water Resources (MWRI). Additional unofficial reuse done by farmers themselves, when they faced shortage in canals water, has been estimated by around 2.8 BCM/year.

The remaining drainage water (12.41 BCM in year 1995/96) is discharged to the sea and the northern lakes via drainage pumping stations.
There are Plans are underway to increase this source in future. Agricultural drainage reuse is considered a significant water source.

2. Wastewater Reuse

The MIWR policy for utilization of reuse of sewage water could be summarized as follows:

- Increase the amount of secondarily treated wastewater use from 0.26 to 2.8 BCM/year 2002 and to 4.5 BCM/year by year 2017.
- Limit the use of treated wastewater to cultivate non-edible crops, such as cotton and afforesting timber trees.

*Separate industrial wastewater from domestic sewage, so that it would be easier to treat domestic sewage with minimum costs and avoid the intensive chemical treatment needed for industrial wastewater.

Environmental monitoring, reclamation and agricultural reuse of mixed low quality water, safe cropping and management systems, technology development and transfer, and training are the basis for this component.

3. Seawater Desalinization

Desalinization of seawater in Egypt as a source of water, has received low priority due, in part, to its high cost (3–7 LE /m^3). Nevertheless, sometimes it is feasible to use this method to prod-
uce and supply drinking water particularly in remote areas where the cost of constructing pipelines to deliver Nile water is relatively high.

WATER EXPENDITURE PER CAPITA

Considering the available water resources, the individual's expenditure in Egypt was reduced from 1893 m^3 / yr at year 1960 to about the half (957 m^3 / yr) at year 2000. It can be divided as 7% for the domestic use and 93% for industrial and agricultural uses. Compared by the minimum demand required per individual (1300 m^3) it can be seen that Egypt is far below that level. It is worth mentioning that the per capita water income in USA, India, and China are 10 000, 2 520, and 2 500 m^3, respectively.

To regulate the Nile flow to the Delta, El-Quanatir Barrages as well as the Aswan Dam were constructed. The purpose was to increase the cultivated area and to maximize the use of the available water. The system of continuous irrigation was achieved by the year 1890 throughout the Delta (El-Nobergy, 1993).

Inventory of Pollution Sources

General

Water Pollution is considered to be one of the most dangerous hazards affecting Egypt. Pollution in the Nile River System (main stream Nile, drains and canals) has increased in the past few decades because of increases in population; several new irrigated agriculture projects, industrial development and other activities along the Nile.

Pollution sources can be divided to:

1) Industrial wastewater pollution;
2) Domestic wastewater pollution;
3) Agricultural pollution; and
4) Pollution originating from dumping of solid waste.

1) Industrial Pollution Sources

1.a *General Overview*

Many industries directly discharging wastes into the River Nile are of importance for the design of the River Nile Monitoring Network.
Industrial pollution sources can be characterized as point sources of a wide variety of pollutants, of which heavy metals and toxic organic compounds generate the most concern. These pollutants originate primary from heavy engineering, electroplating and chemical industries. Of the latter category, industries like pesticides, plastic & rubber manufacturers and petroleum refiners are of particular concern.
With respect to the industrial point sources of pollution for the River Nile; irrigation & drainage canals and sewerage systems, the first inventory was made in **the framework of the Water Master Plan of 1981** (Rose, 1980). In the inventory, 360 main industries were categorized and their production, water use, wastewater discharge and main chemical characteristics of this discharge (BOD, COD, TSS and TDS) measured and put into database. An extract of this database is presented in Table 2.

Table 2: Inventory of Main Industries and Characteristics of Effluent Discharge (Water Master Plan 1980)

Category	Number	Total Discharge [10^6 m^3/yr]	Chemical Characteristics/ Maximum Con-Centrations [Mg/L]			
			BOD	COD	SS	TDS
Agro-industry	110	170	6,800	9,370	10,080	14,200
Chemical	37	134	7,500	13,798	14,825	10,645
Pulp & Paper	18	31	5,400	7,200	3,580	4,680
Transportation	6	1	48	62	12	-
Texile	119	72	4,100	2,300	3,207	8,600
Iron & Steel	17	62	301	607	400	840
Nonmetal. & Mining	11	1	150	381	1,000	428
Cement	8	1,784	76	140	55,000	2,888
Power Generation	13	2,598	-	-	-	-
Miscellaneous	21	7	200	405	280	1,700
Total	360	4,860				

Table 3 : EEAA Database on Industrial Wastewater Discharge of the Major Public Sector Industries in Egypt

Category	Number	Total Discharge (10^6 m^3/yr)	Chemical Characteristics/ Maximum Concentrations (mg/l)				
			BOD	COD	SS	TDS	pH
Chemical	35	42	4,100	21,222	3,077	2.279	4.0-11.0
Electrical	4	1	120	240	88	875	7.5
Engineering	33	6	1,250	17,200	1,318	1,027	2.2-8.0
Fertilizers	6	46	-	750	2,981	1,886	3.0-10.0
Food	61	17	6,800	24,192	6,940	3.026	3.5-12.0
Metal	15	93	940	2,640	2,590	1.680	6.6-9.0
Mining	17	13	1,580	3,990	14,254	4.402	-
Oil & Soap	35	59	3,000	8,400	3,532	5.320	7.0-11.7
Pesticides	1	<1	16	-	-	-	-
Pulp & Paper	11	41	1,040	2,500	9,364	2,004	6.0-8.0
Refractory	12	3	292	4,800	20,100	1,892	6.9-8.0
Sugar	13	136	1.603	2.288	280	2,120	2.7-8.3
Tanneries	1	1	-	136.000	-	-	-
Textile	72	81	640	958	1,716	6,180	3.2-13.0
Wood	5	1	810	530	1,200	1,320	6.7-8.6
Total	321	540					

From the 360 industries, 36 discharge directly to the Nile and its branches, 41 to the irrigation canals, 4 via wells directly into the groundwater, 9 to the sea (Mediterranean Sea and Gulf of Suez), 1 to Lake Mariut and the rest to the public sewer system and the drains. The table illustrated that total BOD loads are highest for the agro-industry (mainly sugar) as well as chemical industry, and that cement industry contributes more than any other to suspended material and total dissolved solids. The biggest water consumer, the power generation industry is hardly contaminating, as the water is mainly used for cooling purposes. No data are available at that time on discharges of toxic substances, but it is suspected that chemical and iron & steel industries are the most polluting sources.

Other information concerning industrial activities and wastewater discharges is contained in database at EEAA. For the unavailability of recent data from EEAA on industrial pollutants we will depend on the information from the technical report on “Design of an Integrated National Water Quality Monitoring Network in Egypt” Report No.2 (June 1996). Based on the situation in 1990, EEAA database lists 321 major public industries discharging into the Nile and its canals. A short overview of the database information is given in Table 3.

Each of the mentioned industries in the EEAA database is characterized by the following information:

(i) Type of industry (chemical, electrical, engineering, fertilizers, food, metal, mining, oil & soap, pulp & paper, refractory, textile, wood); (ii) Location; (iii) Products; (iv) Water consumption; (v) Water discharge; (vi) Sink (sewerage system, sea, drain, canal, underground, River Nile); and (vii) Pollutant concentrations (COD, BOD, TDS, SS, oil, heavy metals) and pH.

Among the most polluting industries are again chemical and food industries (affecting on BOD and COD values) and metal, oil & soap and textile industries (affecting on SS and TDS values). Total heavy metals are mentioned also in the database (e.g. tanneries: 135 mg l^{-1}, chemical, engineering, food, metal, pulp & paper, sugar and textile: between 2 – 8 mg l^{-1}), but it is not clear which metals are measured. As toxicity levels among heavy metals vary considerably, a further analysis from this data is not meaningful. It is again supposed that chemical and metal industries are the most polluting with respect to toxic substances.

The database mentions 27 industries discharging directly to the River Nile, 9 towards the irrigation canals, 20 via wells directly into the groundwater, 5 to the sea (Mediterranean Sea and Golf of Suez) to Lake Mariut and the rest to the public sewerage system and drains.

A further inventory of industries, discharge directly or indirectly to the Nile River was made by NRI. This inventory indicates that, 33 major public industries discharge their effluents directly into the river (Table 4 & 5).

Furthermore, there are more than 90 agricultural drains, which discharge to the River Nile system, a number of them also polluted by industrial wastewater, e.g. Tibeen drain which receive only partly treated industrial effluent from more than 30 major industries in Helwan/Tibeen area (Table 6).

Table 4 Main Industrial Outfalls to the River Nile and its Branches; Point Sources of Pollution

No.	Name	Bank	km from High Aswan Dam[1)]	Discharge[2)] [million m^3/year]	BOD[3)] [mg/l]	TDS[4)] [mg/l]
River Nile main branch:						
1	Komombo Sugar Industry.	RB	50	22.6	178	236
2	Ekleet Power Station	RB	63.6	-	-	-
3	Kalh Power Station	LB	119.6	-	-	-
4	Edfu Paper & Pulp A	LB	122.45	8	128	189
5	Edfu Paper & Pulp B	LB	122.5	included in 4)		
6	Edfu Sugar Industry	LB	123	16.5	128	345
7	Armant Sugar Industry 1	LB	204.5	17.4	105	208
8	Armant Sugar Industry 2	LB	204.51	included in 7)		
9	Armant Sugar Industry 3	LB	204.51	included in 7)		
10	Ques Sugar Industry	RB	246.85	22.6	75	216
11	Grinding Mill	LB	265.4	-	-	-
12	Deshna Sugar Industry.	RB	314	12.1	105	208
13	Aluminium Industry[5)]	?	337.5	5	760	-
14	Naga Hamadi Sugar Industry 1	LB	343.2	22.6	65	213
15	Naga Hamadi Sugar Industry 2	LB	343.25	included in 14)		
16	Onion Industry	LB	443.2	<1	296	572
17	Souhag Oil Industry	RB	445.6	<1	270	-
18	CocaCola Industry	RB	445.61	<1	360	284
19	Assiut Power Station	LB	536	116.2	-	-
20	Mankabad Pipe 1	LB	552.2	11.2	10	1,150
21	Mankabad Pipe 2	LB	552.21	included in 20)		
22	Mankabad Pipe 3	LB	552.21	included in 20)		
23	Tibeen Power Station	RB	901	49.1	-	-
24	Hawamdia Chemical 1	LB	904	13.3	-	-
25	Hawamdia Chemical 2	LB	904.08	included in 24)		
26	Hawamdia Chemical 3	LB	904.3	included in 24)		
27	Hawamdia Chemical 4	LB	904.35	included in 24)		
28	Helwan Power Station	RB	909.2	308.2	-	-
29	Chemical Industry	LB	911.4	5	1,480	2,279
30	Hawamdia Sugar Molasses	LB	911.9	<1	17	282
31	Hawamdia Sugar Pipe 1	LB	912.1	18	188	283
32	Hawamdia Sugar Pipe 2	LB	912.11	included in 31)		

Table 4 **Main Industrial Outfalls to the River Nile and its Branches; Point Sources of Pollution**

No.	Name	Bank	km from High Aswan Dam[1]	Discharge[2] [million m^3/year]	BOD[3] [mg/l]	TDS[4] [mg/l]
33	Hawamdia Sugar Pipe 3	LB	912.12	included in 31)		
34	Hawamdia Sugar Pipe 4	LB	912.12	included in 31)		
35	Hawamdia Sugar Pipe 5	LB	912.13	included in 31)		
36	Hawamdia Sugar Pipe 6	LB	912.13	included in 31)		
37	Kotsica Starch & Glucose 1	RB	915	1.5	1,603	2,120
38	Kotsica Starch & Glucose 2	RB	916.55	included in 37)		
39	El Nasr Glass Tube 1	RB	939.6	<1	22	-
40	El Nasr Glass Tube 2	RB	939.61	included in 39)		
41	El Nasr Glass Tube 3	RB	939.61	included in 39)		
42	El Nasr Glass Tube 4	RB	939.62	included in 39)		
43	El Nasr Glass Tube 5	RB	939.62	included in 39)		
44	Sakeel Power Station	LB	946.25	555	-	-
Rosetta branch:						
45	El Malaya Company	RB	1,074.51	4.6	15	1,886
46	Salt & Soda Company	RB	1,074.51	6.6	1,580	4,402
Damietta branch:						
47	Talkha Fertilizers No. 1	LB	1,098	18.8	-	1,200
48	Talkha Fertilizers No. 2	LB	1,098.12	included in 48)		
49	Faraskour Wood Industry	RB	1,166	-	-	-

1) Data from NRI

2) Data compiled by NRC, from [Rose, 1981] and [EEAA, 1994], completed with dat measured by NRI in April 1994

3) Data compiled by NRC, from [Rose, 1981] and [EEAA, 1994], completed with dat measured by NRI in April 1994

4) Data compiled by NRC, from [Rose, 1981] and [EEAA, 1994], completed with dat measured by NRI in April 1994

5) According to EEAA this industry now injects waste water into the groundwater

Table 5 Most Important Drains in Upper and Middle Egypt[1)]

no.	name	km from HAD[2)]	bank	type[3)]	discharge[4)] (million m^3/year)	drainage area[5)] (fed-dan)
1	Khour El Sail Drain	9.90	RB	A[6)]	25	-[7)]
2	Tawansa Drain	37.25	RB	A	7	-
3	Ghaba Drain	46.55	RB	A	104	-
4	Main Daraw Drain	48.85	RB	A	34	3,300
5	Fatera Drain	70.45	RB	A	381	49,000
6	Khour El Sail Drain (Komombo)	70.75	RB	A+I	113	6,500
7	Edfu Drain	116.20	LB	A	90	19,000
8	Mahameed Drain	135.60	RB	A	7	1,000
9	Mataana Drain	187.70	LB	A	116	34,000
10	Khour El Sail Drain (Qena)	288.80	RB	A+I	-	-
11	Naga Hammadi Drain	377.80	LB	A	278	57,000
12	Souhag Drain	444.55	LB	A	253	56,500
13	Tahta/Raima Drains	487.60	LB	A+I	-	-
14	Badary Drain	525.40	RB	A	231	29,000
15	Etsa Drain	701.10	LB	A	323	84,000
16	Ahnasia Drain	807.20	LB	A	306	96,000
17	Zawia Drain	841.00	LB	A	42	-
18	Dessamy Drain	865.20	RB	A	10	-
19	Tibeen Drain	898.10	RB	A+I	58	-

1) compiled by NRC

2) data from [HADSERI, 1992]

3) data provided by NRI

4) data provided by NRI

5) data from [Ministry of Irrigation, 1981]

6) A = mainly agricultural; I = mainly industrial; D = mainly domestic (or a combination)

7) no data available

Table 6: List of Drains & Industrial Effluents

Serial No.	Km from Aswan	Name	Description
1	6.000	Aswan Sewerage Drain	Sewerage Drain
2	9.900	Khour El Sail Drain	Agricultural Excess Water
3	37.250	El Tawansa Drain	Agricultural Excess Water
4	42.500	El Sheikh Ibrahem Drain	Agricultural Excess Water
5	46.550	El Ghaba Drain	Agricultural Excess Water
6	47.150	Abu Wanas Drain	Agricultural Excess Water
7	48.000	El Shatb Drain	Agricultural Over Flow from Canal
8	48.850	Main Draw Drain	Agricultural Excess Water
9	49.100	El Berba Drain	Agricultural Excess Water
10	50.000	Kom Ombo Sugar Ind.	Industrial Effluent
11	51.000	Kom Ombo Drain	Agricultural Excess Water
12	53.000	Benban Drain	Agricultural Excess Water
13	55.000	Meneha Drain	Agricultural Excess Water
14	57.650	Main Ekleet Drain	Agricultural Excess Water
15	63.600	Ekleet Power Station	Power Station
16	64.650	Berak El Raghama Drain	Agricultural Excess Water
17	70.450	Fatera Drain	Agricultural Excess Water
18	70.750	Khour El Seil Drain	Mixed from Water & Ind.
19	73. 850	Selesta Drain	Agricultural Excess Water
20	75.750	Kagouk Drain	Agricultural Excess Water
21	76.000	Awarta Drain	Agricultural Excess Water
22	99.850	Radisia Drain	Agricultural Excess Water
23	101.750	Hasia Drain	Agricultural Excess Water
24	109.250	Hager Drain	Agricultural Excess Water
25	116.200	Edfu Drain	Agricultural Excess Water
26	119.600	Kalh Power Station	Power Station
27	122.450	Edfu Paper Pulp A.	Industrial Effluent
28	122.500	Edfu Paper Pulp B.	Industrial Effluent
29	123.000	Edfu Sugar Ind.	Industria Effluent
30	135.600	El Mahameed Drain	Agricultural Excess Water
31	139.500	Houd El Sabaia	Agricultural Excess Water
32	143.100	Hagz El Bahary Drain	Agricultural Excess Water
33	147.000	Seba Phosphate Drain	Industrial Effluent
34	149.100	Hagar El Sebia Drain	Agricultural Excess Water
35	187.700	Mataana Drain	Agricultural Excess Water
36	196.700	Ghoreara Drain	Agricultural Excess Water
37	204.500	Armant Sugar Ind. 1	Industrial Effluent
38	204.505	Armant Sugar Ind. 2	Industrial Effluent
39	204.510	Armant Sugar Ind. 3	Industrial Effluent
40	209.000	El Salamia Drain	Agricultural Excess Water
41	220.800	El Mraibia Drain	Agricultural Excess Water from Canal
42	220.850	El Rayayna Drain	Agricultural Excess Water
43	224.500	Outlet Loxur Water Treat.	Industrial Effluent
44	236.000	El Zeinia Drain	Agricultural Excess Water

Table 6 (continued)

Serial No.	Km from Aswan	Name	Description
45	237.700	Habail El Sharky Drain	Agricultural Excess Water
46	245.100	El Shanhoria Drain	Agricultural Excess Water
	246.850	Ques Sugar Ind.	Industrial Effluent
47	251.550	Danfik Drain	Agricultural Excess Water
48	265.300	Sheikhia (El Hagaza) Drain	Agricultural Excess Water
49	265.400	Grinding Mill	Industrial Effluent
50	270.700	El Ballas Drain	Agricultural Excess Water
51	275.900	Kaft (Qift) Drain	Agricultural Excess Water
52	286.750	El Tramasa Drain	Agricultural Excess Water
53	288.800	Khour El Saik Quena	Mixed from Agr. & Ind.
54	299.750	Bahari Dandra Drain	Agr. Excess Water from Canal
55	314.000	Deshna Sugar Ind.	Industrial Effluent
56	331.200	Hamad Drain	Agricultural Excess Water
57	333.500	Salamia Drain	Agricultural Excess Water
58	337.500	Alumenium Ind.	Industrial Effluent
59	340.350	Magrour Hoe Drain	Agricultural Excess Water
60	343.200	Naga Hammadi Sugar Ind. A	Industrial Effluent
61	343.250	Naga Hammadi Sugar Ind. B	Industrial Effluent
62	363.000	Abu Homar Power Station	Power Station
63	377.800	Naga Hammadi Drain	Agricultural Excess Water
64	384.000	Abu Shousha Drain	Agr. Excess Water from Canal
65	392.750	Mazata Drain	Agricultural Excess Water
66	432.700	Essawia Drain	Agricultural Excess Water
67	443.200	Onion Ind.	Industrial Effluent
68	444.550	Souhag Drain	Agricultural Excess Water
69	445.600	Souhag Oil Ind.	Industrial Effluent
70	445.605	Coca Cola Ind.	Industrial Effluent
71	454.700	Seflak Drain	Agricultural Excess Water
72	473.850	Ekhmeem Drain	Agricultural Excess Water
73	486.400	Raaina Drain	Agr. Excess Water from Canal
74	486.700	Tahta Drain	Agricultural Excess Water
75	520.800	Abu Teeg Drain	Agricultural Excess Water
76	525.400	El Badary Drain	Agricultural Excess Water
77	525.850	El Metmar Drain	Agricultural Excess Water
78	536.000	Assuit Power	Power Station
	537.000	Assuit Water Treat. Plant	Industrial Effluent
79	541.600	Selim Drain	Agricultural Excess Water
80	544.259	Marawana Drain	Agricultural Excess Water
81	550.200	El Zenar Drain	Agricultural Excess Water
82	552.200	Mankabad Pipe 1	Industrial Effluent
83	552.205	Mankabad Pipe 2	Industrial Effluent
84	552.210	Mankabad Pipe 3	Industrial Effluent
85	588.600	Bany Shaker Drain	Agricultural Excess Water
86	637.400	El Rayamoun Drain	Agricultural Excess Water
87	642.750	Abu Henis Drain	Agricultural Excess Water

Table 6 (Continued)

Serial No.	Km from Aswan	Name	Description
88	682.000	Minia Water Treat. Plant	Industrial Effluent
89	682.500	Makoussa Drain	Agricultural Excess Water
90	701.100	Etsa Drain	Agricultural Excess Water
91	752.150	El Sheikh Zied Drain	Agricultural Excess Water
92	780.500	Ebsug Drain	Agricultural Excess Water
93	807.000	Beni Suif Water Plant	Industrial Effluent
94	807.200	Ahnasia Drain	Agricultural Excess Water
95	808.000	El Saayda Drain	Agricultural Excess Water
96	841.000	El Zawia Drain	Agricultural Excess Water
97	848.900	Khour El Sail Atfih Drain	Agricultural Excess Water
98	865.200	El Dessamy Drain	Agricultural Excess Water
99	871.300	Kafr Gazara (El Saaf) Drain	Agricultural Excess Water
100	879.600	El Masanda Drain	Agricultural Excess Water
101	888.900	Ghamaza El Soghra Drain	Agricultural Excess Water
102	888.950	Ghamaza El Kobra Drain	Agricultural Excess Water
103	898.100	El Tibeen Drain	Mixed from Agr. & Draoin
104	901.000	Tibeen Power Station	Power Station
105	904.000	Hawamdia Chemical 1	Industrial Effluent
106	904.080	Hawamdia Chemical 2	Industrial Effluent
107	904.300	Hawamdia Chemical 3	Industrial Effluent
108	904.350	Hawamdia Chemical 4	Industrial Effluent
109	909.200	Helwan Power Station	Power Station
110	910.150	Khour Sail El Badrashin	Mixed from Agr. & Industrial
111	911.400	Chemical Ind.	Industrial Effluent
112	911.900	Hawamdia Sugar Maulas	Industrial Effluent
113	912.100	Hawamdia Sugar Pipe 1	Industrial Effluent
114	912.105	Hawamdia Sugar Pipe 2	Industrial Effluent
115	912.115	Hawamdia Sugar Pipe 3	Industrial Efffluent
116	912.120	Hawamdia Sugar Pipe 4	Industrial Effluent
117	912.125	Hawamdia Sugar Pipe 5	Industrial Effluent
118	912.130	Hawamdia Sugar Pipe 6	Industrial Effluent
119	912.900	Khour Sail El Masara Drain	Mixed from Agr. & Industrial
120	916.550	Kotsica Starch & Gluc. Dr.	Industria Effluent
121	916.551	Kotsica Starch & Gluc. Dr.	Industrial Effluent
122	939.600	El Nasr Glass tube 1	Industrial Effluent
123	939.605	El Nasr Glass tube 2	Industrial Effluent
124	939.610	El Nasr Glass tube 3	Industrial Effluent
125	939.615	El Nasr Glass tube 4	Industrial Effluent
126	939.620	El Nasr Glass tube 5	Industrial Effluent
127	946.250	Sakeel Power Station	Power Station
128	947.800	Delta Cotton at Kanater	Industrial Effluent
R1	962.850	El Rahawy Drain	Mixed from Agr. & Industrial
R2	1024.400	Sabal Drain	Agricultural Excess Water
R3	1039.500	El Tahreer Drain	Agricultural Excess Water
R4	1053.700	Zaweit El Bahr Drain	Agricultural Excess Water
R5	1073.400	Tata Drain	Agricultural Excess Water
R6	1074.500	Pesticides Company	Industrial Effluen

Table 6 (C0ntinued)

Serial No	Km from Aswan	Name	Description
R7	**1074.505**	**El Malaya Company**	**Industrial Effluent**
R8	**1074.510**	**Salt & Soda Company**	**Industrial Effluent**
D1	**1098.000**	**Talkha 1 Fertilizers**	**Industrial Effluent**
D2	**1098.120**	**Talkha 2 Fertilizers**	**Industrial Effluent**
D3	**1124.500**	**Batra Drain**	**Agricultural Excess** Water
D4	**1125.200**	**High Serw 1**	**Agricultural Excess Water**
D5	**1135.300**	**High Serw Power Station**	**Power Station**
D6	**1166.000**	**Faraskour**	**Industrial Effluent**

The report on the Nile System Pollution Sources (2002) mentioned that according to the physico-chemical characteristics of industrial outlets between Aswan and Delta Barrage for the year 1998 and 1999 (Table 7), most of these outlets are not complying with the standards given in the Article 61 of Law 48/1982 regarding discharge of industrial wastewater into the Nile River. In general major sources of pollution from industries are sugar factories in Kom-ombo, Ques, Aramant, Deshna and El-Hawamdia and the oil and Coca-Cola factories in Souhag.

The industries in the EEAA database are classified according to different categories compared with the Water Master Plan. These categories only partly overlap and comparison of the database is difficult. Some industries present in the database of NRI do not figure in the EEAA database. The major water users, the power generation industry and the (strongly polluting) cement industry are not mentioned in the EEAA database.

Although the number of industries discharging directly to the Nile is quite similar in all three references (Master Plan; NRI and EEAA database), the information is otherwise little consistent. From the 33 industries mentioned in the NRI database, only 19 are mentioned in the database of the water Master Plan and only 15 in the EEAA database (out of 25 non-power generating industries). Other, mentioned in the Water Master Plan and EEAA databases, do not figure in the NRI database. Data on pollutant concentration vary widely, even for the same industries in the three databases.

Table (7) Physico-chemical Characteristics of Industrial Point Sources Discharging into the Nile River (From Aswan to El-Kanater)

No.	Location from AHD (KM)	Point Source	Bank	BOD		COD		TSS		Oil & Grease		Ammonia	
				1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
		Consent standard		30 mgO_2/l		40 mgO_2/l		30 mg/l		5 mg/l		NA	
1	50.000	Kom Ombo Sugar Ind.	R.B.	144	760	3072	1500	58	46	1.2	9.3	0.01	0.01
2	63.600	Ekleet power station	R.B.	1.2	4.8	2	84	28	79	1.21	2.55	0.01	0.01
3	119.600	Kaleh Power Station	L.B.	1.4	2.0	5	40	15	32	2.26	3.09	0.01	0.10
4	122.450	Edfu Paper Pulp A	L.B.	12	78	27	622	9	158	1.45	11.10	0.01	0.35
5	122.500	Edfu Paper Pulp B	L.B.	13	75	19	354	9	25	0.36	2.81	0.05	0.01
6	123.000	Edfu Sugar Ind.	L.B.	12	260		370	72	35	0.2	7.4	0.01	0.13
7	147.000	Sebaia Phosphate Ind.	R.B.							0.87			
8	204.500	Armant Sugar Ind 1	L.B.		70		161		15		9.6		0.10
9	204.505	Armant Sugar Ind 2	L.B.										
10	204.510	Armant Sugar Ind. 3	L.B.										
11	257.000	Ques Sugar Ind.	R.B.		33		59		20		3.36		0.01
12	265.400	Ginning Mill	L.B.										
13	314.000	Dishna Sugar Ind.	R.B.	74	67	178	800	32	20	0.55	8.32	0.01	0.01
14	337.500	Aluminum Ind.	L.B.										
15	343.200	Naga Hammadie Sugar A	L.B.	12	54	20	117	12	23	1	4.04	0.01	0.01
16	343.250	Naga Hammadie Sugar B	L.B.										
17	443.200	Onion Ind.	L.B.										
18	445.600	Souhag Oil Ind.	L.B.	1	75	8	260	20	61	9.4	5.87	0.01	0.14
19	445.605	Cocacola Ind.	L.B.		75	42	260	397	61	5.53	5.87	0.01	0.14
20	454.700	Seflak Ind.	R.B.		5.4	101	9	12	41	2.66	0.7	0.01	0.1

No.	Location from AHD (KM)	Point Source	Bank	BOD		COD		TSS		Oil & Grease		Ammonia	
				1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
21	552.200	Mankabad Pipe 1	L.B.		1.5	5	22	13	28	-	2.04	0.7	0.15
22	552.205	Mankabad Pipe 2	L.B.										
23	552.210	Mankabad Pipe 3	L.B.										
24	904.000	Hawamdia Chemical 1	L.B.										
25	904.008	Hawamdia Chemical 2	L.B.										
26	904.300	Hawamdia Chemical 3	L.B.										
27	904.350	Hawamdia Chemical 4	R.B										
28	909.200	Helwan Power Station	R.B.										
29	911.400	Chemical Ind.	L.B.		420		5600		79		48.4		0.17
30	911.400	Hawamdia Suger Moulas	L.B.		445		6000		166		50.2		0.01
31	912.100	Hawamdia Sugar Pipe 1	L.B.	73	440	687	3850	51	285		17.6	0.16	2.51
32	912.105	Hawamdia Sugar Pipe 2	L.B.	33.5	58	591	77	190	25		2.73	0.01	0.01
33	912.115	Hawamdia Sugar Pipe 3	L.B.	2	86	4	185	76	61		3.64	0.01	0.01
34	912.120	Hawamdia Sugar Pipe 4	L.B.	71		1220		131				1.0	
35	912.125	Hawamdia Sugar Pipe 5	L.B.	23		48		48		6.44		0.01	
36	912.130	Hawamdia Sugar Pipe 6	L.B.										
37	915.000	Iron Steel Ind.	R.B.										
38	916.550	Kotsica Starch & Glucose	R.B.										
39	916.551	Kotsica Starch & Glucose	R.B										
40	939.600	El Nasser Glass Tube 1	R.B.	2		27		36		4.39		0.3	
41	939.605	El Nasser Glass Tube 2	R.B.										
42	939.610	El Nasser Glass Tube 3	R.B.										

No.	Location from AHD (KM)	Point Source	Bank	BOD		COD		TSS		Oil & Grease		Ammonia	
				1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
43	939.615	El Nasser Glass Tube 4	R.B.										
44	939.620	El Nasser Glass Tube 5	R.B.										
45	947.900	Delta Cotton Kanater	R.B.	5		8		27		3.36		0.01	

L.B. = Left bank
R.B = Right bank

1.b.Geographical distribution

The aforementioned EEAA database clearly demonstrates geographic differences in the distribution of different types of industry. Table 7 illustrates this for the data used in the EEAA database. For the cement and power generation industries, the table was completed with the data from the Water Master Plan database.

From the table it becomes clear that certain heavily polluting industries have a specific geographical distribution, like cement in the southern Cairo area, chemical in Alexandria and the northern Cairo area, food and oil & soap in Alexandria and the Delta, metal in the Greater Cairo area, sugar in Upper Egypt and textile in Alexandria, the Delta and northern Cairo area.

Most of the aforementioned information is based on numbers of public industries, rather than production capacity and pollution loads.

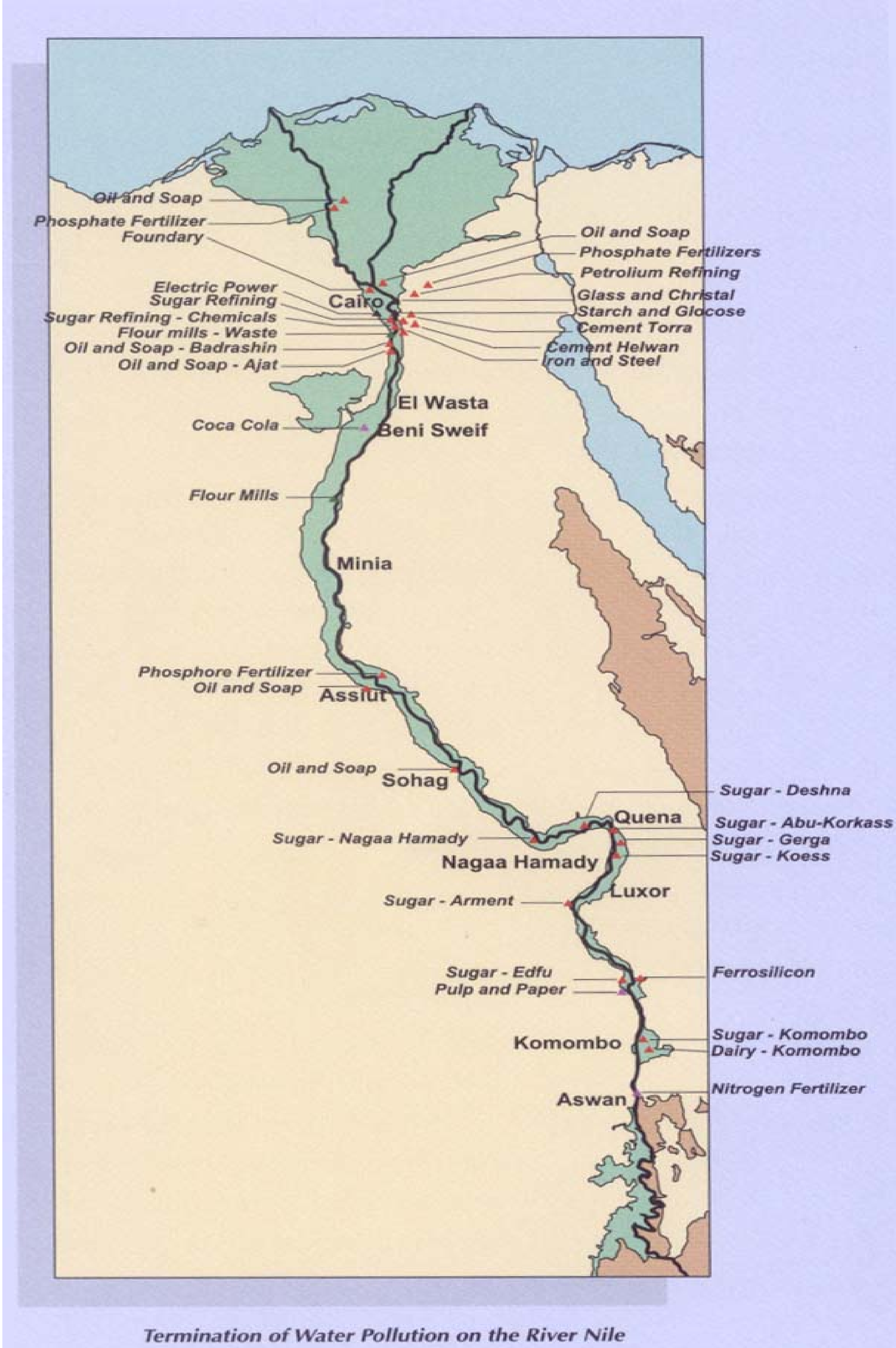
For those industries discharging to open water systems, standards are violated in approx. 95% of the cases. From the available data it becomes clear that the pollution is most severe in the drainage canals and sewerage systems (which in turn discharge their treated or non-treated effluent to the drainage canals and the River Nile), followed by the River Nile and the Irrigation Canals. As the drains in the Delta discharge to the Northern Lakes and the Mediterranean Sea, the coastal area inevitably gets its grim share of water pollution.

The following map showed the termination of water pollution on the River Nile.

Table 8 : Geographic Distribution of Different Types of Industry (EEAA Database)

Category	Alexandria & Canal	Delta	Cairo North Area(1)	Cairo South Area(2)	Upper Egypt
Cement	1			3	
Chemical	10	3	14	7	1
Electrical	3			1	
Engineering	2		26	5	
Fertilizers	2	2			2
Food	25	16	6	7	7
Metal	4	1	4	4	2
Mining	14	1			2
Oil & Soap	13	14	4	2	2
Pesticides		1			
Power Generation	4	3	3	2	2
Pulp & Paper	5	1	4		1
Refractory	3		5	3	1
Sugar			2	2	9
Tanneries			1		
Textile	19	24	20	2	7
Wood	1		2	1	1
Total	105	66	91	36	37

1) Greater Cairo, except Helwan / Tibeen and southern Giza area (Dokki and Lower).
2) Helwan / Tibeen and southern Giza area.



the River Nile Termination of Water Pollution on

1.c. *The Recent Situation*

Recently, a field survey for the industrial establishment has carried out by EEAA in order to cover the following points:

- Study for the condition of wastewater disposal and the outlets besides studying the chemical analyses that exists in the factories in order to highlight the parameters that are not complying with the law.
- Determine the size and the kind of environmental problems especially that related to wastewater in the industrial units and the company plan in order to comply with the environmental law and what are the parries towards the implementation and to determine how far the treatment units are working.
- Discussion for the steps taken from the factories for pollution control and prevention and to determine how far the wastes are complying with the law and to determine the efficiency of the treatment units.
- To take a look on the environmental record for the factory, if it is existed, and make the recommendations.

They reach the following conclusions**:**
It is clear that the geographic distribution for units that are discharging their wastewater on the River Nile is as follows: 11 units in Greater Cairo; 2 units in the Delta; and 18 units in Upper Egypt.

Accordingly, in year 2003 a series of visits were arranged from the staff members of The General Organization for Industrialization for the aforementioned units in order to determine so far they are complying with the law and the environmental legislations. Also to determine the problems and barriers that prevents the factories to take effective steps for limiting the pollution resulting from their activities and to stop discharge their wastes on the River Nile.

The situation of the 31 industrial establishments under study concerning the treatment and discharging on the River Nile is as follows:
1- Although there are eight units have already treatment units, they still discharging their wastes on the River Nile or its branches (El-Kahera Factories for oil & Soap at El-Badrashein and El-Ayaat – Salt & Soda Factory at Kafr El-Zyaat – Coca-Cola Factory at Bani-Sweif- El-Nil Factory for Oil & Soap at Bany Korrah – Edfu Factory for paper pulp & writing paper; Quina for paper at Couss; and Kima Factory for fertilizers at Aswan).
2- Seven Units changed from discharging on the River Nile to the sewerage system (El-Nasr Co for Glass & Crystal at Shoubra El-Khima; El-Nasr Co for Casting at Tanash; El-Kahera Co for Oil & Soap

at El- Kanater; Suppletory Industries at El-Hawamdia which transport their wastes to wastewater treatment plant at Athar El-Naby with river units; El-Masria Co, for Starch & Glucose at Tura; Pepsi-Cola Co, and El-Nile Co, for Oil & Soap at Souhag). Five units, out of the seven, have treatment facilities.

3- 13 units have units for water re-use (e.g., Portland for Cement at Toura, Iron & Steel Co, at Tibeen, El-Maleya and Industrial at Kafr El-Zyaat, Sugar and Suppletory Industries at Dyshna and Nagaa Hammadi, Gerga, Kom-Ombo, Edfuo, Koos and Aramant).

4- Four units discharge their wastes on Lakes that evaporate or use it for trees irrigation that exist in Abou-Zaabal Co, for Fertilizer at Abou-Zabaal and Portland for Cement Co, at Helwan.

5- One unit trying to have a fund for establishing a treatment unit to treat their liquid wastes (El-Masreya Co., for iron Ingots & Ferrosilicon).

There are some positives observed through the field study which can be summarized in the following points:

- Most of the units have environmental awareness and included environmental departments with environmental records (uncompleted or not renewed in some units).
- Re-use for wastewater, after treatment, is followed in some units, and some units recovering the loss of raw material from the waste.
- Closed system for cooling is followed for water conservation and to prevent thermal pollution.

Barriers and problems are:

- The unavailability of funds.
- The use of underground water by some factories led to the problem of not complying with the dissolved solids and heavy metals parameters.
- The steps that would be taken in order to connect the factory with the sewerage system are complicated and slow. Discharging on the sewerage system and stopping discharging the wastes on surface water economically is the ideal solution, because discharging wastes on surface water is controlled by strict standards and need tertiary treatment to be complied with the standards.
- Some factories discharge their wastes on agricultural drains which are connected with the River Nile, so it is indirectly discharge their wastes on the River Nile. These factories should be complying with the standards of law 48/1982.

Recommendations:

- Sewerage system should be expand, extend, developed and up dating in order to have the capacity to receive the wastes from factories. The steps necessary to connect the factories with the sewerage system should be simplified. These protect the River Nile from discharging the waste on, and less expensive than to have a special treatment unit for factories.
- The costs for inspection and monitoring should be lowered; certified centers for inspection should be prepared with the suitable equipments and staff members for every industrial area. The factories can contract with them for sampling and analysis with economic costs.
- Awareness through meetings, conferences and workshops is necessary to explain the importance and how to have an environmental record to be ready continuously at any time.
- Evaluation for the wastewater treatment plants that exist in factories should be carried out in order to define how far it possible to have outlet complying with the law.
- Availability of funds for the factories to have the wastewater treatment facilities should be studied.
- Reinsuring the importance of pollution control and prevention at the source. Factories can do it with little cost through:

* The production line should be inspected to limit or prevent the losses in raw materials.
* Factory floors should be clean and prevent the infiltration of raw materials.
* Oil traps should be available to limit oil discharge on the waste line. *
*Industrial waste should not be mixed with sewage in order to limit the problems in wastewater treatment plants.
* Closed cycles for cooling systems should be followed in order to limit water losses.
* Minimizing the use of chemicals and having the good quality at the same time.
* Maintenance for wastewater treatment units is necessary to have high efficiency for treatment processes.
* Waste treatment unit should working continuously with the design capacity limits to have effluent complying with the law.

1.d *Data Analysis*

From the study of the available data (Water Master Plan (1981), EEAA (1990) and NRI), it seems that the NRI information gives the most comprehensive picture of River Nile industrial pollution. Based on the information, the main industrial pollution sources have been listed in Table 4. In the same table, total yearly discharge, BOD load and TDS load have been presented, based on measurements of NRI and MOH. This information is based on incidental measurements and values in the table do not pretend to be very precise, but mainly indicative.

Furthermore, 3 agricultural drains, returning to the River Nile, have been identified that have major industrial outfalls (sugar industries at Kom-Ombo and Quena and Tibeen Drain in the Helwan/Tibeen area (metal, cement, food, chemical). These drains are listed in Table 5.

In Upper Egypt (km 50 to km 552 from the High Aswan Dam) the industrial pollution sources mainly comprise outfalls from sugar industries (9 outfalls directly to the Nile and 2 on drains discharging to the Nile); food and beverage industries (4 outfalls); paper industries (2 outfalls); power stations (3 outfalls); and chemical/ fertilizer (3 outfalls). These types of industries are mainly expected to pollute the receiving water with more or less readily degradable organic waste material (sugar/ food/ beverage industries), suspended matter (paper); salts (fertilizer) and heat (power stations).
Between km 552 and km 900 there is no significant industrial pollution.

In the Greater Cairo area (Km 900 to km 950) the major industrial outfalls also comprise sugar industry (6 outfalls), food and beverage (3 outfalls) and power stations (3 outfalls), but in general this area can be characterized by more heavy types of industry (5 outfalls from chemical industry, 5 outfalls from glass industry, 1 outfall from iron & steel industry). Moreover, this reach of the river receives heavy polluted industrial drainage water, containing waste of the iron and steel industry and the cement industry in Helwan/Tibeen area (Tibeen Drain). These types of industry tend to pollute the receiving water with suspended matter, heavy metals and all kinds of organic micro-pollutants.

Irrigation canals also receive industrial wastewater, at least 40 industries could be identified that discharge to the irrigation canals. With exception of the Isamilia Canal, they seem only to generate moderate pollution. In the Ismailia Canal, 5 industries could be identified, discharging in the first 15 km of the canal. The canal also serves drinking water purposes in the cities of Port Said, Ismailia and Suez. The industries comprise a starch & glucose factory, a fertilizer company, a chemical industry (also pesticide production) a pharmaceutical industry and an engineering industry (motor cars).

More precise information, needed for quantitative predictions of effects of industrial discharges on water quality has not emerged during the study.

As conclusion, till 1998, most of heavy industrial facilities are discharging their treated or partially/non-treated wastewater effluent into River Nile, agricultural drains, canals and sewerage system. At present industrial use of water is estimated at 5.9 BCM/year out of which 550 MCM/year is discharged untreated into the River Nile.
125 major industrial plants are located in the Nile valley which represents about 18% of the existing industries and discharging 15% of the heavy metal loads.
250 industrial plants are located in Greater Cairo which represents 35% and contributing about 40% of the total metal discharges.
The Delta excluding Alexandria has some 150 industries which contribute about 25% of the heavy metals discharging to drains. Alexandria is a major heavy industrial center with some 175 industries, about 25% of the total in Egypt.
The recent data obtained from The General Organization for Industrialization (2003) included the approximate quantity of wastewater that resulted from cooling, industrial processes as well as human wastes. In general major sources of pollution from industrial activities in the Nile course are sugar factories (Kom-ombo, Quoos, Aramant, and Hawamdia), Oil factories (Souhag) and Coca-Cola factory (Souhag). Some of the 31 factories that discharge their wasted on Nile River already reduced their wastes through treatment or recycling.
Growing industrialization is taking place resulting in an increase in the volume of effluents and toxic wastes and in the variety of toxic contaminants discharged into waterways that are recycled in the food chain creating health hazards.

The Government Efforts in the Field of Industrial Sustainable Development in Egypt

- The Egyptian legislation has been concerned with the environmental resources since long time; and has organized the human activities that affect the environment. The EEAA staff was prepared to enforce the Environmental Impact Assessment (EIA) for all the existed activities that may affect the environment as well as for the new project before getting the license. In addition it is necessary for any establishment to have an environmental record which inspected by EEAA staff.

- Major industries have been visited in view of their non-compliance with respect to wastes that may affect the environment. Compliance Action Plans (CAP's) are being agreed upon to obtain a grace for compliance.
- The Egyptian industries directed to the application of clean production technologies through the frame of renewing of the industrial establishments. This can be achieved through waste control ; use of raw materials that not affect the environment and the application of economic ways for re-use the waste materials resulted during production. A national strategy for clean production in the Egyptian industries have been implemented (through a committee from 9 ministries) and applied.
- The Egyptian government encouraged the establishing of the new industrial cities in order to eliminate the industrial pollution in the existed cities. Through these new industrial cities, the natural resources in the Egyptian desert will be used in different productive activities considering that it is possible to provide the environmental management services with much more high efficiency and with low investments.
- For the appearance of numerous environmental problems in the new industrial cities, the EEAA encouraged a new program to make them environmentally friend cities. The regulations and standards in order to establish communities that have environmental friend activities through the law 4/1994 should be fixed and be known for all investors. The project implementation begin since 1998 in 5 industrial cities.
- 87 industrial wastewater treatment plants were established to discharge the treated waste on sewerage system or on surface water according to the standards and regulations.
- A main component of occupational health include the environmental conditions inside and outside the establishment in the industrial areas as well as in industrial cities. Air filters, change the power sources, cleaner production, green areas and solid wastes management are considered.
- A national program for prevention the industrial pollution discharge in water resources was begin in 1996 in four phases by EEAA. The first three phases are focusing on the River Nile and drains ending in lakes, while the fourth is concerned with the Mediterranean Sea.

2) Domestic wastes

Population studies and rates of water consumption, the total wastewater flows generated by all Egyptian governorates, assuming full coverage by wastewater facilities is estimated to be 3.5 BCM/year. Approximately 1.6 BCM/year receives treatment. By the year 2017, an additional capacity of treatment plants equivalent to 1.7 BCM is targeted (National Water Resources Plan, 2002). The expected future increases in the capacity of wastewater treatment plants will be insufficient to cope with the actual increase in wastewater production resulted from population increases. Therefore, the untreated loads that will reach water bodies are not expected to decrease in the coming years as demonstrated by the following table (Table 9).

Table 9 : Projection of Wastewater Treatment Coverage

Year	Population	People Served	People not Served
1997	60 Million	18 Million	42 Million
2017	83 Million	39 Million	44 Million

The alarming increase in the discharge rates of municipal and domestic wastes rendered the occasional primary treatment of urban sewage even insufficient to prevent deterioration of vital water streams (Parker, 1987). Furthermore, secondary treatment cannot be satisfactory in emphasizing the quality of wastewater for unrestricted reuse or in preventing further pollution by pathogenic microorganisms (Cairncross, 1989).

In the rural areas accommodating about half of the population (35 million), 75% of the people have no access to sewerage systems or wastewater treatment facilities. Septic tanks are the common disposal facility where excreta and a limited amount of water can be collected for biological digestion. The digested excreta leach into the soil surrounding the tank and hence shallow groundwater are subjected to contamination. Thus, it is important to adapt inexpensive and simple technology systems regardless to their large area requirement, particularly for sewage treatment (i.e., ponds; artificial wetlands and gravel hydroponics).

As sanitary waste in such areas will be disposed of in another way, this situation makes domestic waste water a widespread non-point source of contamination of not only agricultural drains, but also of fresh water bodies like the Nile and the irrigation canals.

Evaluation of the available data and random verification of the real situation shows that the information is not very reliable and/or up to date. Therefore, the Water Pollution Control Department of National Research Center (NRC) was asked to compile a new list regarding the present state of waste treatment plants in Egypt. This list is shown in Table 10. Figures 4 (a) to (d) give the approximate locations of the treatment plants mentioned in Table 10. Figure 5 gives an overview of cities and towns in Egypt along the Nile.

The influence of domestic wastewater on the water quality of the effluent receiving water body depends on the form of treatment of the wastewater. For the countryside, where there exist no sewerage systems, domestic wastewater production is low (4 times lower) per capita than in urban areas and the pathways to the surface and/or groundwater may be relatively long. In Urban areas, where there is a sewage collecting and no treatment, pollution load high and pathways towards the receiving water bodies are short. Consequently, pollution of the receiving water is high. In urban areas that provide good secondary treatment for their wastewater, the pollution load is relatively low. At the same time, pollution with toxic substances will be better controlled than in the other two cases. The aforementioned is summarized and supported by some exemplary figures in Table 11.

Table 11. Domestic Wastewater Emission in Egypt and its Consequences for Environmental Pollution

Situation	Per Capita Waste production	BOD Concentration of Effluent	BOD load of Effluent	Path way	Emission Reaching Surface Water
Rural areas without any treatment	60 l/d	500 mg/l	30g/c/d	long	30%
Urban areas without any treatment	250 l/d	500 mg/l	125 g/c/d	short	100%
Urban areas with Secondary treatment	250 l/d	30 mg/l	8 g/c/d	short	100%

59 waste water treatment plants with total capacity of approx. 3,700,000 m^3 /day are operational; 34 are under construction, with a total capacity of almost 5,000,000 m^3 /day. Most of the installed treatment plants provide some form of secondary treatment, although repeatedly not all of them are functioning well as demonstrated in Table 12 which contained data abstracted from the operational sheet of five treatment plants in Greater Cairo. Table 13 gives a geographical overview of the operational wastewater treatment facilities on the Nile River system.

Especially in the Greater Cairo area, high levels of toxic substances in sewage are reported (Taylor Binnie & Partners, 1992). As those toxic substances (heavy metals, toxic organic substances) will be mainly attached to suspended materials, most of it will be removed by appropriate secondary treatment. Nevertheless, the remaining toxic substances may still contaminate surface waters. Moreover there is no national program in Egypt for sludge disposal. Improper sludge disposal may lead again to contamination of surface and groundwater.

Table 10 Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]

Location	Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
UPPER EGYPT				
Aswan Governorate				
Aswan city	O	26,000	AOP	Sail Drain
Aswan city	C	35,000	OD	Sail Drain
Edfu	P	20,000	nd	nd
Komombo	P	20,000	nd	nd
Abu Sombal	P	2,000	nd	nd
Nasr El-Nobah	P	2,000	nd	nd
Qena Governorate				
Qena city	O	25,000	TF	land reclamation
Qena city	C	27,000	TF	land reclamation
Luxor	O	22,000	TF	land reclamation
Luxor	P	16,000	TF	nd
Abu Teshet	P	20,000	TF	nd
Esna	P	2,000	nd	nd
Naga Hamadi	P	10,000	nd	nd
Deshna	P	10,000	nd	nd
Armant	P	10,000	nd	nd
Qus	P	20,000	nd	nd
Nafady	P	20,000	nd	nd
Farshut	P	10,000	nd	nd
Souhag Governorate				
Souhag city	O	25,000	TF	Souhag Drain
Souhag city	C	60,000	TF	Souhag Drain
Jirja	P	20,000	nd	nd
Tahta	P	20,000	nd	nd
Tema	P	20,000	nd	nd
Sakalta	P	10,000	nd	nd
Dar El-Salam	P	10,000	nd	nd
Manshah	P	10,000	nd	nd
Juhayna	P	10,000	nd	nd
Maragha	P	10,000	nd	nd
Balyana	P	10,000	nd	nd
Awlad Hamza	P	10,000	nd	nd

Table 10 Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]

Location	Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
Assiut Governorate				
Assiut city	O	30,000	TF	land reclamation
Assiut city	C	50,000	TF	land reclamation
Manfalut	P	20,000	TF	nd
Abnub	P	20,000	nd	nd
Abu Tij	P	20,000	nd	nd
Dairut	P	20,000	nd	nd
Qusiyah	P	20,000	nd	nd
Sahel Salem	P	10,000	nd	nd
Ghanaim	P	10,000	nd	nd
Sadafa	P	10,000	nd	nd
Fatah	P	10,000	nd	nd
Mankabad	P	10,000	nd	nd
Minia Governorate				
Minia	O	19,000	TF	Moheat Drain
Minia	C	30,000	TF	Moheat Drain
Fikriya	C	40,000	AS	Dalera Drain
Adwah	P	3,000	nd	nd
Matay	P	10,000	nd	nd
Dair Moase	P	10,000	nd	Moheet Drain
Maghagha	P	20,000	TF	Moheet Drain
Samalut	P	20,000	TF	Moheet Drain
Beni Mazar	P	20,000	TF	Moheet Drain
Mallawi	P	40,000	TF	Flomom Drain
Beni Suef Governorate				
Beni Suef city	O	38,000	TF	Moheet Demoshia Drain
Samusta	P	18,000	nd	nd
Ahnasia	P	10,000	nd	nd
Biba	P	20,000	TF	Ahmed Basha Drain
Fashn	P	20,000	TF	Beni Saleh Drain
Wasita	P	20,000	TF	nd
Fayoum Governorate				
Fayoum city	O	40,000	TF	Bats Drain
Fayoum city	C	40,000	AS	Bats Drain

Table 10 Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]

Location	Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
Senuris	P	20,000	AOP	nd
Tamiya	P	10,000	nd	nd
Etsa	P	10,000	nd	nd
Ibshawia	P	10,000	nd	nd
Fidimin	P	10,000	nd	nd
GREATER CAIRO				
Gabal Al-Asfar	C	3,000,000	AS	Belbais Drain
Berka	O	600,000	AS	Belbais Drain
Balkes	C	600,000	AS	Shbeen Kanater Drain
Abu Rawash	O	720,000	PT	land reclamation
Zenein	O	330,000	AS	Nahiah Drain
Helwan	O	35,000	AS	land reclamation
NILE DELTA				
Qalubiya Governorate				
Banha	O	75,000	TF	Tala Drain
Banha	C	75,000	AS	Tala Drain
Qalyub	C	90,000	EA	Sendbes Drain
Shebeen Kanater	C	13,000	EA	Belbais Drain
Tukh	C	16,000	EA	Lake Manzala
Kafr Shoker	C	15,000	nd	nd
Khanika	C	20,000	nd	nd
Kanater	C	20,000	nd	nd
Mit Kenana	C	10,000	OD	Rwasha Drain
Mensha Kanater	P	10,000	nd	nd
Qaha	P	10,000	nd	nd
Seriakos	P	10,000	nd	nd
Arab Aliakat	P	2,000	nd	nd
Minufiya Governorate				
Minuf	O	26,000	AS	Minuf Drain
Minuf	C	26,000	AOP	Minuf Drain
Shebeen Al-Kawn	O	74,000	TF	Shenwan Drain
Kawn Aghdar	O	600	Aqualife	Kawn Drain
Quesna	C	10,000	OP	Kodrayia Drain
Meleeg	P	10,000	ND	Kodrayia Drain

Table 10 **Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]**

Location	Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
Azba Ashmon	P	10,000	ND	Kodrayia Drain
Birkat Sabaa	P	20,000	TF	Mahlet Roh Drain
Batanun	P	20,000	TF	Tala Drain
Shohadaa	P	20,000	TF	Omoum Drain
Ashmun	P	20,000	AOP	Sevel Drain
Tala	P	20,000	AOP	Talboha Drain
Sharqiya Governorate				
Zagazig	O	90,000	AS	Aslogy Drain
Hihiya	O	10,000	OD	Hod Nagia
Bilbeis	P	40,000	TF	Belqus Drain
Abu Kabir	P	20,000	TF	Abu Shok Drain
Kaniate	P	20,000	TF	Aqua Drain
Karesh	P	20,000	TF	Kafr Aziz Drain
Abu Hamad	P	20,000	TF	Miased Drain
Menia Qamh	P	20,000	TF	Qalub Drain
Faqus	P	20,000	TF	Bahr Baqar Drain
Zanklan	P	10,000	nd	nd
Ibrahimia	P	20,000	nd	Ibrahimia Drain
Hosania	P	10,000	nd	nd
Mashtul Suq	P	10,000	nd	nd
Diarb Negm	P	10,000	nd	nd
Kafr Saker	P	10,000	nd	nd
Awlad Sagar	P	10,000	nd	nd
San Hagr	P	10,000	nd	nd
Beheira Governorate				
Damanhur	O	48,000	TF	Khairi Drain
Kafr Dawar	O	40,000	TF	Deshary Drain
Shubrakhit	O	12,000	TF	Shubrakhit Drain
Mahmoudia	O	12,000	TF	Natf Drain
Mahmoudia	P	20,000	ND	Natf Drain
Edko	P	20,000	AOP	Al- Bouseli Drain
Hosh Essa	P	20,000	AOP	Sidi Isa Drain
Abu Homs	P	20,000	AOP	Abu Hummus Drain
Fardy	P	2,000	AOP	nd

Table 10 Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]

Location	Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
Rashay	P	2,000	nd	nd
Wadi Natron	P	2,000	nd	nd
Itia Barud	P	10,000	nd	nd
Kawn Hamada	P	10,000	nd	nd
Rahamna	P	10,000	nd	nd
Fraza	P	10,000	nd	nd
Dilingat	P	10,000	nd	nd
Abu Matamir	P	27,000	TF	nd
Gharbiya Governorate				
Tanta	O	22,000	AOP	Sebrai Drain
Tanta	O	60,000	AOP	Sebrai Drain
Mahala Kubra	O	60,000	TF	Bakar Drain
Mahala Kubra	C	80,000	AOP	Bakar Drain
Kafr Zayat	O	90,000	AS	Grang Drain
Kafr Zayat	C	12,000	AOP	Grang Drain
Samanud	O	34,000	TF	Omar Bey Drain
Shenrak	P	2,000	nd	nd
Bernra	P	2,000	nd	nd
Mit Yazid	P	10,000	nd	nd
Mahala Zayad	P	2,000	nd	nd
Mahala Roh	P	10,000	nd	nd
Beshbesh	P	10,000	nd	nd
Kato	P	10,000	nd	nd
Safat Trab	P	10,000	nd	nd
Mahalet Marhum	P	10,000	nd	nd
Mit Brah	P	10,000	nd	nd
Kafr Al-Sheikh Governorate				
Kafr Al-Sheikh	O	15,000	TF	Drain No.7
Hamul	P	20,000	AOP	El-Ghabia Drain
Biyala	P	20,000	AOP	Kafr Arab Drain
Fowa	P	20,000	nd	nd
Brollos	P	10,000	nd	nd
Riyad	P	10,000	nd	nd
Baltim	P	10,000	nd	nd

Table 10 Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]

Location	Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
Motobis	P	10,000	nd	nd
Kelim	P	10,000	nd	nd
Sidi Salem	P	10,000	nd	nd
Daqahliya Governorate				
Mansoura	O	16,000	TF	Mansoura Drain
Mansoura	C	80,000	AS	Mansoura Drain
Mit Mazah	O	75,000	OP	Mansoura Drain
Shubra Sendy	P	2,000	nd	nd
Mit Al-Asmel	P	2,000	nd	nd
Damas	P	2,000	nd	Om Salama Drain
Simbillawain	P	20,000	AOP	Om Salama Drain
Talkha	P	20,000	AOP	Senblawen Drain
Dekernes	P	20,000	AOP	Omam
Maasara	P	20,000	TF	Behara Drain
Gamaliya	P	20,000	TF	Behara Drain
Bilqas	P	20,000	AOP	nd
Manzala	P	20,000	AOP	Merga Drain
Shirbeen	P	20,000	AOP	Bilqas Drain
Mit Ghamr	P	40,000	AOP	Bilqas Drain
Matariya	P	40,000	nd	nd
Aga	P	10,000	nd	Al-Hawber Drain
Mit Salsil	P	10,000	nd	nd
Kom Al-Noor	P	10,000	nd	nd
Nabruh	P	10,000	nd	nd
Beni Abeid	P	10,000	nd	nd
Temi Amdid	P	2,000	nd	nd
Mit Al-Rorma	P	2,000	nd	nd
Mahala Damana	P	2,000	nd	nd
Batra	P	2,000	nd	nd
Damietta Governorate				
Damietta	O	90,000	AS	Lake Manzala
Kafr el Batikh	O	2,600	OD	agricultural drain
Khiata	O	1,300	OP	agricultural drain
Adliya	O	300	OP	agricultural drain

Table 10 Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]

Location	Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
Ras El-Bar	O	50,000	EA	Mediterranean Sea
Azbat El-Borg	C	16,000	OP	Lake Manzala
Al-Hawrany	C	10,000	EA	Faraskour Drain
Kafr Saad	O	18,000	EA	agricultural drain
Kafr Saad(Bold)	O	620	Aqualife	agricultural drain
Kafr Ghab	O	2,200	Aqualife	agricultural drain
Kafr Soliman	O	1,320	OD	agricultural drain
Mit Abu Ghaoly	O	550	EA	agricultural drain
Wastany	O	550	EA	agricultural drain
Zarka	C	20,000	OP	agricultural drain
Seriw	O	1,100	EA	El-Siala Drain
Mitkdy	O	550	EA	agricultural drain
Dakhla	O	62,000	OP	agricultural drain
Faraskour	C	21,000	OP	agricultural drain
Roda	O	1,100	EA	agricultural drain
Ghaniemia	O	550	EA	agricultural drain
Sharabas	O	550	EA	agricultural drain
Kafr Arab	O	550	EA	agricultural drain
Brayeshia	O	620	Aqualife	agricultural drain
Rhamna	O	1,320	OD	agricultural drain
OTHERS				
Alexandria				
East	O	475,000	AS	Lake Mariut
West	O	175,000	AS	Lake Mariut
Ismailiya Governorate				
Ismailiya	O	40,000	TF	Al-Mahsma Drain
Ismailiya	C	90,000	OP	Al-Mahsma Drain
Sarabiyum	C	90,000	OD	nd
Tall Kabir	C	10,000	OD	Wady Drain
Abu Kalefa	P	10,000	nd	nd
Qantara	P	2,000	nd	nd
Qasasin	P	10,000	nd	nd
Fayid	P	10,000	nd	nd

Table 10 Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]

Location	Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
<u>Suez Governorate</u>				
Suez city	O	60,000	OP	Gulf of Suez
Suez city	C	130,000	OP	Gulf of Suez
<u>Port Said Governorate</u>				
Port Said city	O	50,000	TF	Lake Manzala
Port Said city	C	190,000	AS	Lake Manzala
<u>Red Sea Governorate</u>				
Hurghada	O	20,000	OP	land reclamation
Qusair	P	2,000	nd	nd
Safaga	P	2,000	nd	nd
<u>Marsa Matruh Governorate</u>				
Marsa Matruh	no information available			
Hammam				
Dabaah				
Siwa				
Borg El-Arab				
Sidi Barrani				
<u>North Sinai Governorate</u>				
Balota	P		nd	nd
Hasna	P		nd	nd
Rafah	no information available			
Nakhel				
Arish	O		OP	Mediterranean Sea
<u>South Sinai Governorate</u>				
Tur	C	4,000	OP	nd
Sharm El-Sheikh	C	4,000	OP	nd
Dahab	C	4,000	OP	nd
Nuwaiba	C	4,000	OP	nd
Ras Gharib	P	2,000	nd	nd
Abu Ranimah	P	1,000	nd	nd
Sint Catherine	P	1,000	nd	nd
<u>Wadi El-Gadid Governorate</u>				
Dakhla	O	2,000	OP	nd
Dakhla	C	10,000	nd	nd

Table 10 Overview of Existing and Planned Waste Water Treatment Plants in Egypt[1)]

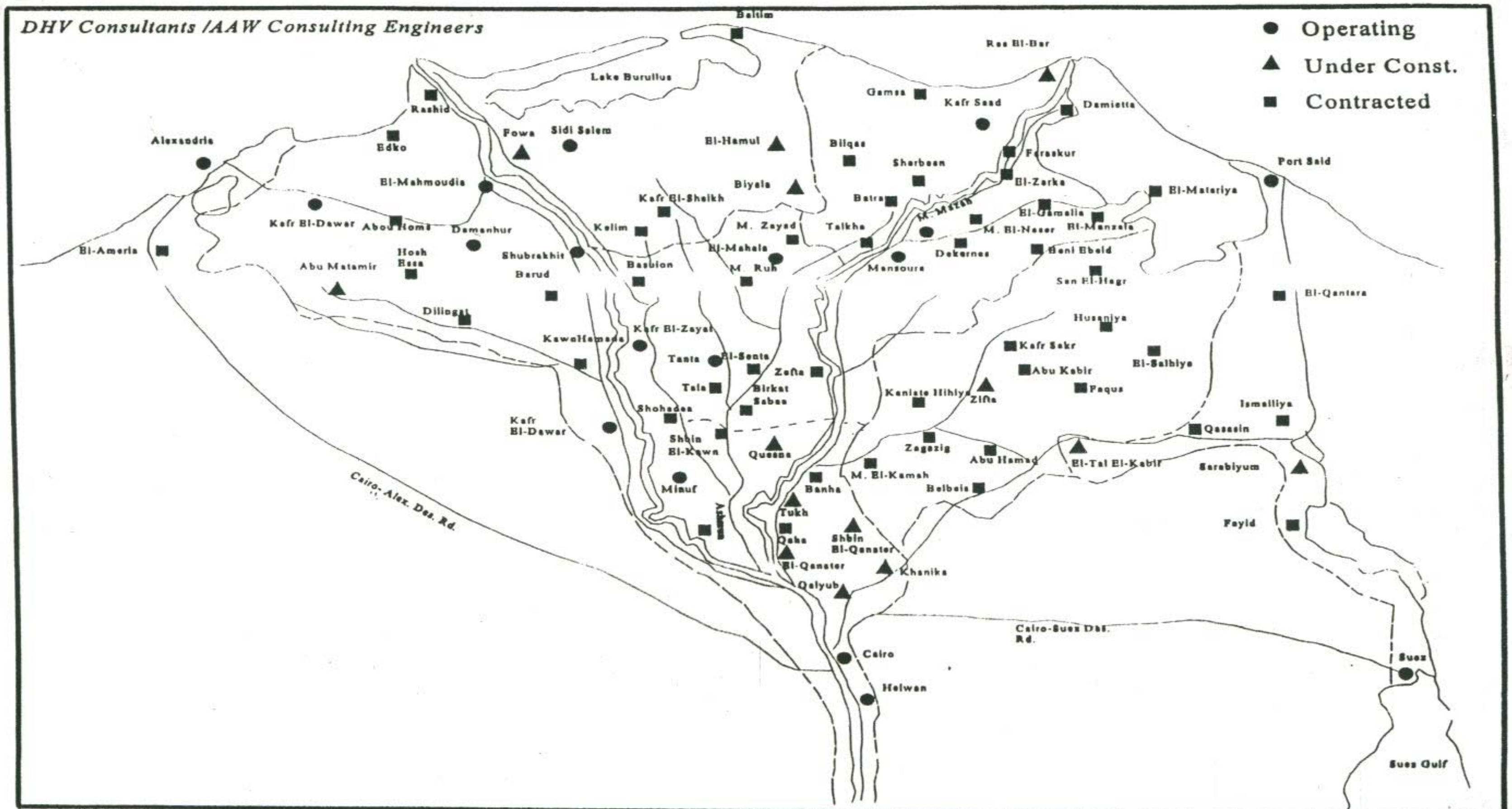
Location			Facility status	Capacity [m3/day]	Type of treatment[2)]	Sink
		Al- Kharga	O	2,000	OP	

[1)] Information compiled by NRC from various sources

[2)] Type of treatment:

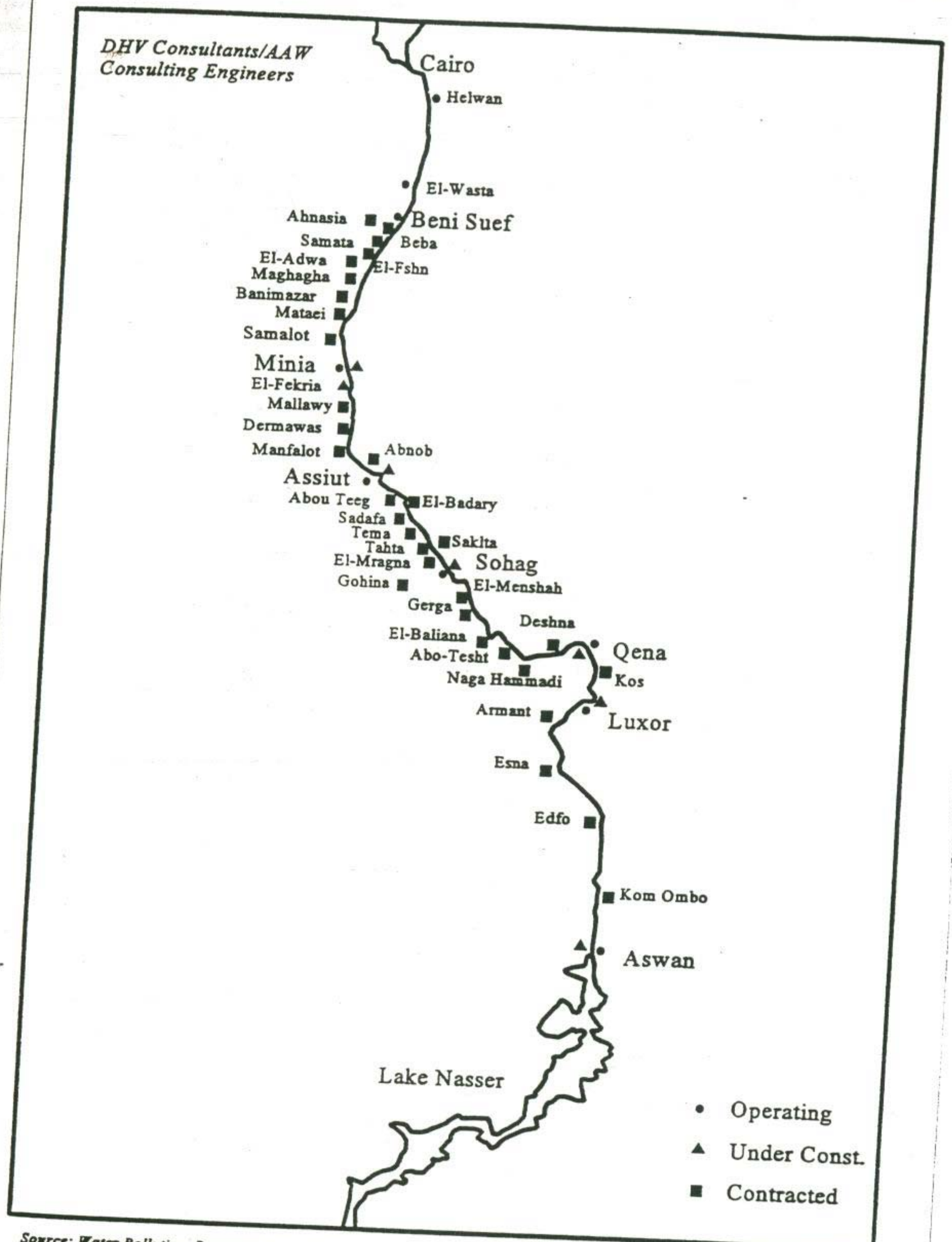
PT = Primary Treatment only
TF = Trickling Filter (secondary treatment)
AS = Conventional Activated Sludge (secondary treatment)
EA = Extended Aeration (Activated Sludge)
OD = Oxydation Ditch (Activated Sludge)
OP = Oxydation Ponds (Stabilization Ponds; secondary treatment)
AOP = Aerated Oxydation Ponds (Stabilization Ponds; pre-secondary treatment)

Figure 4 a Waster Water Treatment Plants in Lower Egypt



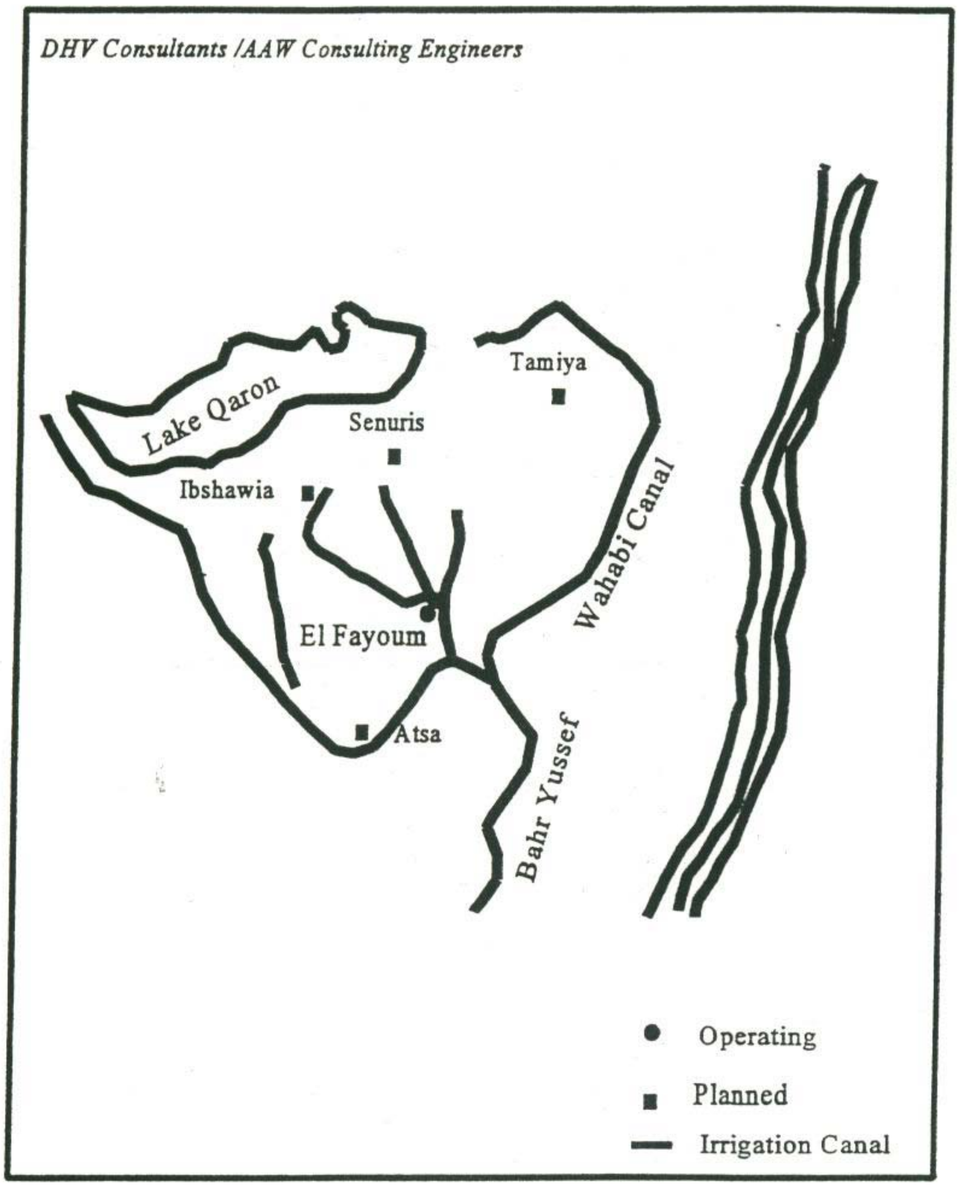
Source: Water Pollution Research Dept., National Research Centre, Cairo, Eygpt.

Figure 4 b Waste Water Treatment Plants in Upper Egypt



Source: Water Pollution Research Dept., National Research Centre, Cairo, Eygpt.

Figure 4c Waste Water Treatment Plants in Fayoum



Source: Water Pollution Research Dept., National Research Centre, Cairo, Eygpt.

Figure 4.d Waste Water Treatment Plants in the Western Desert

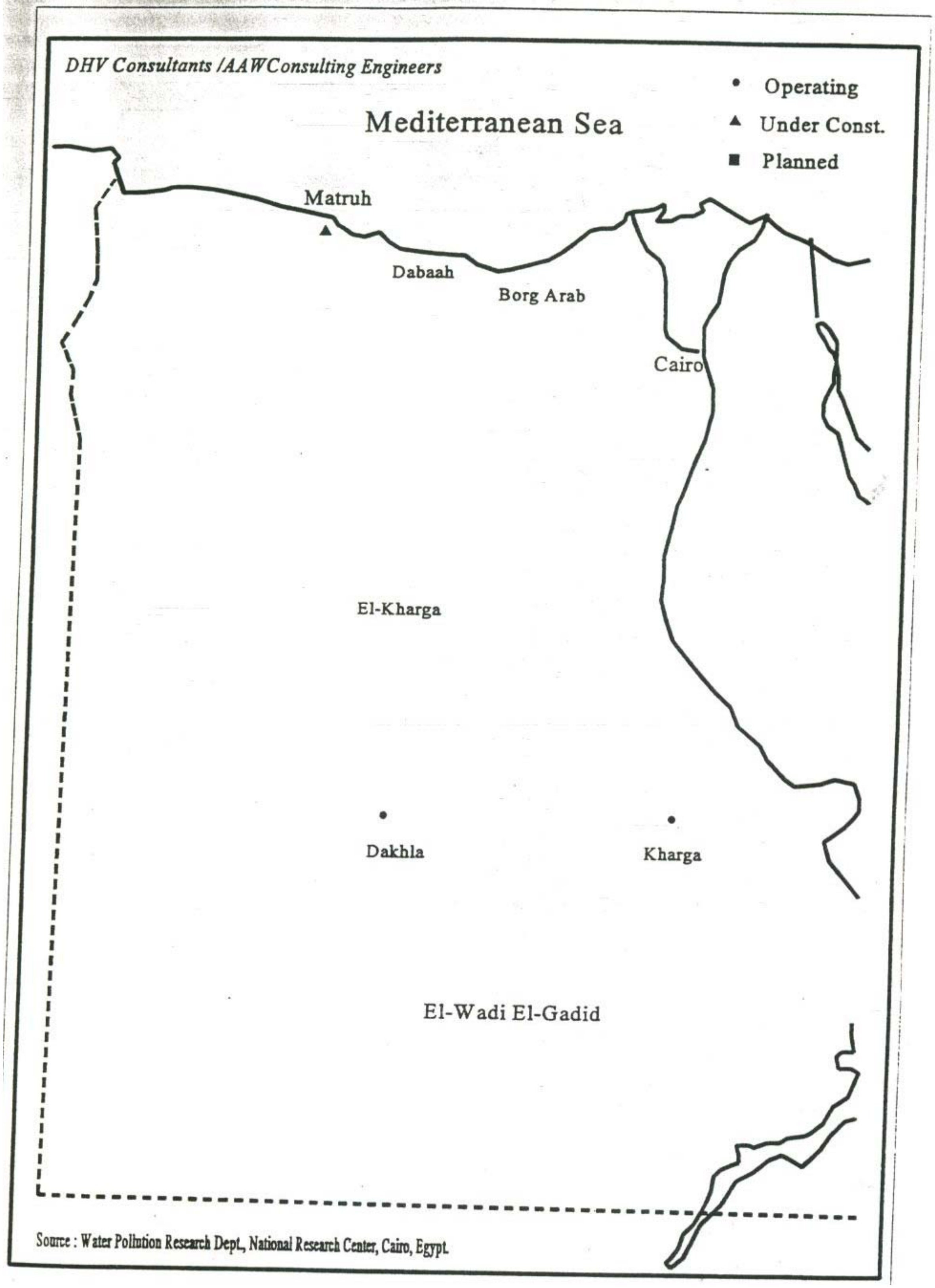
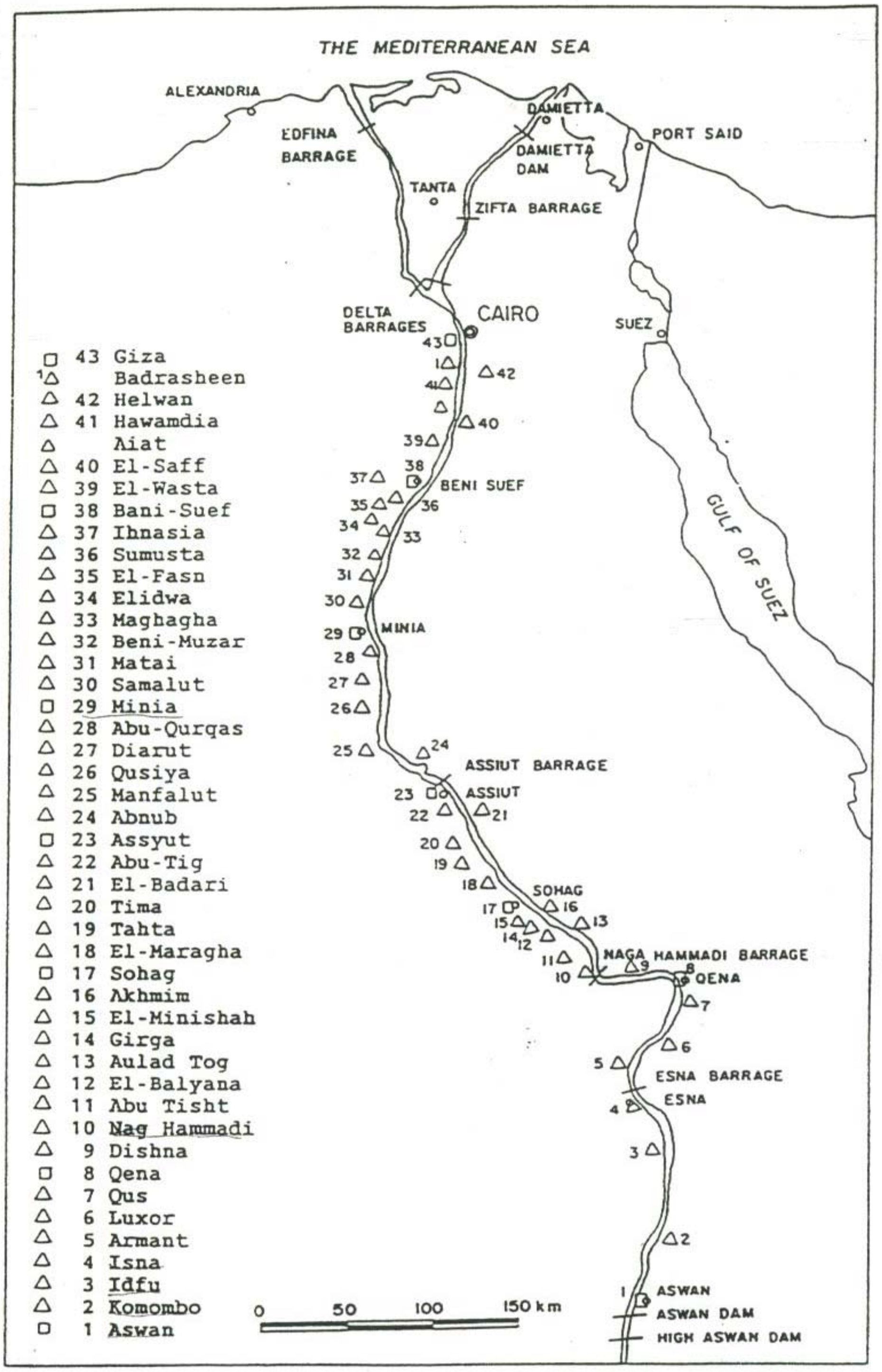


Figure 5 Towns and Cities along the River Nile from Aswan to Cairo



Source: NRI

△ Towns
□ Capital of Governorate

Table 12. Summary of Monthly Report on Wastewater Treatment Plants in Greater Cairo Organization of Sanitary Drainage for Greater Cairo

Parameter	El-Berka		Zenin			Helwan 2004		Abou Rawash		Shoubra El-Khima 2004(Balqas)		
	March 2004	Nov. 2004	March 2004	Nov. 2004	December 2004	March	Nov.	March 2004	Nov. 2004	March 2004	Nov. 2004	December 2004
Designe Capacity(10^3 m^3 / day)	400	400	600	600	600	350	350	400	400	600	600	600
Average (Monthly) Treated Waste (10^3 m^3 / day)	800	800	484	473	478	400	400	800	800	484	473	478
BOD Inlet (mg/I)	307	316	221	237	231	247	270	307	316	221	237	231
BOD Outlet (mg/I)	106	106	148	75	12	27	35	106	106	148	75	12
Maximam BOD Removal (%)	63	68.4	46	-	-	92	90	63	68.4	46	-	-
Minimum BOD Removal (%)	69.3	61.8	1.9	-	-	86	86	69.3	61.8	1.9	-	-
COD Inlet. (mg/l)	-	-	478	-	-	-	-	-	-	478	-	-
COD Outlet (mg/l)	-	-	267	-	-	-	-	-	-	267	-	-
SS Inlet (mg/l)	351	356	212	268	220	623	810	351	356	212	268	220
SS Outlet (mg/l)	101	76	94	24	11	32	40	101	76	94	24	11
Maximum SS Removal(%)	70.9	79.1	75	-	-	97	95	70.9	79.1	75	-	-
Minimum SS Removal(%)	67.1	79.1	36	-	-	92	93	67.1	79.1	36	-	-
Average of Sludge Produced m^3/day	-	-	2831	3553	3484	2000	2000	-	-	2831	3553	3484
Debris on Screens m^3/month	-	-	74 ton/month	72 ton/ month	69 ton/month	12	15	-	-	74 ton/month	72 ton/ month	69 ton/month

Table 13. Overview of (functioning) (domestic) Wastewater Treatment Facilities on the Nile River System [1)]

Region Treatment Plant Facility	Type of Treatment	Discharge Towards	Capacity [m^3/day]
Upper Egypt 8 Treatment Plants	1 aerated Oxidation Pond,7 Trickling Filter	Mainly Agricultural Drains,Some to Land Reclamation	225.000
Greater Cairo **Helwan**	Activated Sludge	Land Reclamation	35.000
Berka	Activated Sludge	Agricultural Drain	600.000
Zenein	Activated Sludge	Agricultural Drain	330.000
Abu-Rawash	Only Primary Treatment	Land Reclamation	720.000
Delta **Alexandria East**	Activated Sludge	Lake Mariut	475.000
Alexandria West	Activated Sludge	Lake Mariut	175.000
Zegazig	Activated Sludge	Agricultural Drain	90.000
Banha	Trickling Filter	Agricultural Drain	75.000
Shibeen Al-Kawn	Trickling Filter	Agricultural Drain	74.000
Tanta	Aerated Oxidation Pond	Agricultural Drain	60.000
Mahalla Kubra	Trickling Filter	Agricultural Drain	60.000
Kafr Al-Zayat	Activated Sludge	Agricultural Drain	90.000
Mit Mazah	Oxidation Pond	Agricultural Drain	75.000
Damietta	Activated Sludge	Lake Manzala	90.000
Ras El-Bar	Extended Aeration	Mediterranean Sea	50.000
Dakhla	Oxidation Pond	Agricultural Drain	62.000
28 Other Facilities	Oxidation Pond Aerated Oxidation Pond Extended Aeration Oxidation Ditch Trickling FilteActivated Sludge Aqualife	Mainly Agricultural Drains and Lake Manzala	228.000

1) Only plants with a capacity > 50.000 m^3 / day are listed separately.

3) **Agricultural Pollution**

In the context of water quality management, agriculture must be seen as a widespread non-point source of pollution. Pollutants include leached salts, nutrients like nitrogen and pesticides. These non-point sources will be collected in agricultural drains to form point sources of pollution for the River Nile, lakes and irrigation canals in case of mixing water for reuse. Although there are different mechanisms for retaining the pollutants by passing the polluted water through soil, the non-point sources of pollution may influence the groundwater quality.

The cultivated area is covered with networks of irrigation canals (about 30,310 km) and of field drains and collectors (about 17,200 km of the main drainage system). In Egypt, the annual watering balance reckons with incomes of 45.5×10^9 and 6.5×10^9 m^3 / year to the old conventional and reclaimed lands, respectively, and with outputs of 35×10^9 and 17×10^9 m^3 /year via vegetal consumption and waste into the drainage network, respectively. In the downstream direction, the water quality gradually deteriorates due to the poorly treated wastewater discharges from both domestic and industrial activities and uncontrolled mixing with water from polluted drains. Therefore, they contain high levels of various pollutants, such as fecal bacteria, heavy metals and pesticides. Some drains should be considered as open sewage system that badly due to the production of hydrosulfide.

3. a *Pesticides*

According to the list of pesticides used in Egypt in 1995, the most used pesticides and their active ingredients are:

Mancozeb (mainly for cotton and rice); organophosphorous type;

Dimethoate (mainly for cotton); organophosphorous type;

Chloropyrophos (vegetables); organophosphorous type; and

Methomyl (more or less equally divided over cotton, vegetables and potatoes), **Carbamate** type.

Table 14 summarize the quantity of the most frequently used pesticides, applied in different governorates.

Relative pesticide use per Feddan is highest around Cairo diminishes towards Upper Egypt and the coastal areas. Drains originating in the area around Cairo may show higher levels of pesticides.

One should keep in mind, that pesticides do not only enter the environment through agricultural use, but also through the waste of pesticides manufacturing companies (at Kafr El-Zaiat). Locally and regionally through drainage water discharge, such companies can be responsible for a major pollution by pesticides. The problem is

complicated by the fact that pesticides are not easily decomposed (persistent). Examples of some half-life times in water are given in Table 15 for number of pesticides.
Using of herbicides in water ways had been stopped since 1991.

Strategic Approach to Chemical Management

Proper management of hazardous substances (industrial and Agricultural wastes) necessitates reliance on scientific planning that is based on an integrated strategic approach that takes into consideration the technical, legal, institutional, economic and social aspects in view of the interacting global environmental concern not only national or regional dimension but also international aspects should be taken into consideration.
The goal of the strategy is to eliminate/ reduce the risks to human health and the environment from hazardous substances. This can be accomplished through:

- Awareness within all sectors of society of the risks associated with chemicals;
- Prevention i.e., taking steps to avoid or minimize various aspects of chemical pollution, contamination, accidents, and poisoning; and
- Control and management of chemicals which pose risks to health and the environment resulting from extraction, manufacturing, use handling, storage and disposal of chemicals.

Status of Chemical Management in Egypt

The control on using chemicals is one of the ways through which chemical risks to humans and the environment can be adequately managed. The control through legislation's; regulations and guidelines, as minimum requirements to be observed in handling, use, storage and disposal of chemicals. Legal instrument can contribute to more efficient approach to the sound management of chemicals if adhered to their enforcement. Egypt has issued the environmental law (law 4/94). The Ministry of State for Environmental Affairs (MSEA) and the Egyptian Environmental Affairs Agency (EEAA) as well as national agencies have started to enforce the law particularly as regards to the safe handling and transportation of hazardous substances.
The regulatory framework is depicted in Table 16.

Table 14 . Quantity of the Most Frequently Used Pesticides, Applied in the Different Governorates

Governorate	Pesticides used (ton/yuar)				
	Mancozeb	Malathion	Dimethoate	Cblorpyrophos	Metho
Aswan, Qena, Souhag	44	58	24	55	11
Assiut, Minia, Beni Sueif	176	37	127	36	60
Fayoum	55	26	36	26	16
Giza, Cairo	58	70	27	68	18
Qalubiya	58	28	19	27	10
Minufiya	76	36	43	35	27
Sharqiya	150	43	79	42	35
Beheira	219	91	154	88	79
Other governorates Delta	108	77	57	76	32
Total	944	644	566	453	288

Table 15 . Half–life Times of Pesticides in Water [2)]

Pesticide	Half-life time in water
Carbamates (general)	2 weeks – 3 months
Carbofuran (carbamate)	10-21 days
Carbary1 (carbamate)	1500 days (pH 5), 15 days (pH 7), 0.15 da
Herbicides	1-10 weeks
DDT (org.chl.)	2-4 years
Aldrin (org.chl.)	8 days
Dieldrin (org.chl.)	500 days at 25 ˚C (no degradation, only ev
Lindane (org.chl.)	200 days at 25 ˚C (no degradation, only ev
Diazinon (org.phos.)	50-185 days (pH dependent)
Malathion (org.phos.)	3-12 days (pH dependent)

1) Net Cropping Area of the Considered Crops 2) Data Extracted from (Natale,1992 and Verschueren, 1983)

Table 16 : References to Existing in legal instruments, which address the management of chemicals

Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories Covered	Objectives of Legislation
Law No 4 of 1994 Decree No 338 Of 1995	MSEA	Industrial chemicals, Agricultural chemicals (pesticides- fertilizers), Petroleum products, Consumer chemicals and Chemical waste.	Environmental Protection and Pollution Control in Egypt Executive Regulations for Law 4/1994
Decree No 60 of 1986	MOA	Pesticides	Regulates & control of using of restricted compounds
Decree No 258 of 1990	MOA	Fertilizers	Regulates and control the importation of fertilizers
Agriculture Law No 53/1966	MOA	Agricultural Chemicals	Rules regulates production, import, use of pesticides and fertilizers.
Decree No 50/ 1967	MOA	Pesticides	Toxic properties of pesticides and procedures for recording it.
Decree No 590/ 1964	MOA	Fertilizers	Rules regulate production, import, and use of fertilizers
Decree No 874/ 1996	MOA	Pesticides	Regulates importing, handling and using of pesticides.
Decree No 348/ 1996	MoHP	Banned Insecticides	A list of insecticides not allowed to be imported, produced or used.

Agricultural Law no. 53/1966

Article 79

Pesticide Committee to be formed by a ministrial decree from the Minister of Agriculture. The task of the Committee is to specify pesticides to be used in country, determine their specifications, procedure of their registration and condition for use.

Article 80

Based on the recommendations of the Committee, the Minister of Agriculture issues ministerial decree that put the articles of the agricultural law into action particularly those concerning:

1. Kinds of pesticides to be imported for local use, their specifications, conditions of importation and handling.
2. Conditions and procedures of licensing for pesticides importation and trade.
3. Procedure of pesticides registration, registration renewal, registration fees.
4. Methods of pesticides sampling and analysis, ways of disapprobation by the producers on results of chemical analysis, procedures to be followed in considering approbation and judging its validity, and the fees to be paid for such approbation.

Article 82

Advertising or distribution of information on pesticides should comply with its specification and conditions for handling and registration and also with the recommendations of the Ministry of Agriculture for their use.

- Prevention and biological control measures are considered, beside the safe use of plant extracts and other natural substances for pest and disease control.

3. b *Fertilizers*

Very little information could be made available on fertilizer use and its partition over different crops and/or governorates other than that the total amount of fertilizers used in Egypt amounts approx. 6.5 million tons/year. The excess use of fertilizer and the eventual leaching of fertilizer towards surface and groundwater have been further studied. The pollution potential of fertilizers use can be best demonstrated from the fact that if 10 % of the fertilizer leaches to the agricultural drains, drainage water salinity would increase with approx. 50 mg/l. This does not seem dramatic. However, fertilizer mostly consists of nitrates and phosphates, which in concentrations of around 50 mg/l may cause severe eutrophication problems in drainage canals and other water bodies that indirectly receive drainage water.

In Egypt, for example the national average for fertilizer consumption is 347 kg/ha, in Saudi Arabia 336 kg/ha, Pakistan 73 kg/ha, while the US is 42 kg/ha and the world average is 28 kg/ha (Alam and Manzoor, 2005).
All chemicals taken by plants, absorbed by the soil, volatilize in air or leach down with the drainage water, join the groundwater and cause pollution. High level of nitrates is common in irrigated agriculture, especially with intensive agriculture related to surface irrigation and high fertilizer rate.
The World Health Organization estimated that around one million chemical compounds are used worldwide and millions of tons of these chemicals are used annually on lands and environment.
Research has shown that toxicity in plants can be decreased or eliminated. This is possible by the use of biological fertilizers. Bio-organic farming offers solution to the problems facing agricultural practices, Bioorganic farming works in harmony with the natural systems, encourages and enhances biological cycles within the farming system, furnishes conditions of life that allow possible genetic diversity of agricultural system and its surroundings including the protection of plants and wildlife habitats by furnishing conditions that allow all life forms to perform freely their innate behaviours.

Strategies of agricultural development in Egypt

Strategies of agricultural development in Egypt focused during the successive five-year plans, since the inauguration of the economic reform program, on the environmental dimension of development. The plan that focused most on the environmental dimension, was the 4th five year plan (1997/98 – 2001/02), which reviewed several environmental issues related to the agricultural sector, including reducing the increasing use of chemical fertilizers and pesticides that jeopardize the life of citizens. Among the main programs to limit the use of chemicals in agriculture is to provide training and agricultural programs for specialists and advisors, in order to activate their particularly in helping vegetable cultivators who tend to over use chemical fertilizers.

Today, in Egypt, the organic farming system depends on reasonable and continuous applications of composted animal manure and farm wastes and on the use of natural additives for enriching compost, such as rock phosphate, orthoclase, gypsum, desert shale, bone meal, as well as plant and seaweed extracts. Waste recycling is the predominant way of compensating the nutrients removed from the soil.

The Partnership in Development Research Program PDR policy brief series disseminates the results of research which funded by the Netherland Ministry of Foreign Affairs, Development Cooperation. Through this program a study (Eita, Research Brief No. 60) was carried out on the impact of chemicals on agricultural development in Sharkia Governorate in order to reduce environmental pollution resulting from the use of chemicals (fertilizers and pesticides). The following recommendations have been reached:

- Moderate use of chemical fertilizers and pesticides is recommended because of their impact on increasing the cost of productivity per feddan.
- Enhance the role of agricultural cooperatives and advisors to provide technical support and information to farmers on policies and procedures of using fertilizers and pesticides and their potential harmful effect and available alternatives.
- Raise awareness of farmers about the correct way to obtain high productivity while avoiding the excessive use of pesticides and fertilizers or chemical elements.
- Regular monitoring of traders of chemical products particularly with regard to the validity of their products and degree of toxicity.
- Take the necessary precautions during use of chemicals. This applies to farmers as well as individuals who dispose of chemical waste.
- Apply strict control on the importation and exchange of pesticides particularly the prohibited types.

3. c *Salinity*

The salinity measurements made by (Drainage Research Institute (DRI) in the Delta show that closer to the Mediterranean Sea, salinity in the drainage water increases, to reach level close to 10,000 mg/l close to the coast. Although part of the salinity increase may be caused by leaching of salts from the soil, it is believed that most of this increase is caused by upward seepage of brackish groundwater. This theory is supported by observations from DRI and RIGW with regard to chemical composition (major ions) of adjacent drainage and ground water. At the same time, simple calculations show that the present salt load discharged to the Mediterranean Sea can by no means be the result of leaching from the soil.

In the upper reach of the Nile, from Aswan to the Delta Barrage, drainage water returning to the Nile amounts to approx. 5 billion m^3 / year, and salinity in the Nile only increased by 50 – 100 mg/l, depending on the season and the hydrological conditions. This means that the average salinity of the drainage water discharge to the Nile amounts to approx. 40-800 mg/l, including industrial and domestic discharges, also from the industrial area at Helwan.

4. Solid wastes

Dumping of solid waste outside the specifically assigned areas is illegal in Egypt and, although it is recognized as a source of pollution for surface and groundwater, no specific information on this practice is available. It is considered to be mainly a point source of pollution for especially irrigation and drainage canals in the vicinity of towns and villages. No further analysis of this source of pollution has been made.

Solid Waste Management

The National Programme for Solid Waste Management that MSEA/EEAA issued and approved by the Governors' Council, which the Prime Minister heads in December 2000 is the framework to regulate the collection and disposal processes. It addresses issues, such as the shortage of landfill sites for the final disposal of waste financing of waste management as between the public budget, which is the main source of finance for waste management, and user-fee components. There is shortage of financial and human resources to deal with the volumes of waste that are generated on a daily basis as well as the need to remove the accumulated wastes of the streets. The absence of landfills and the shortage of collecting and transporting methods have increased the accumulated Municipal Solid Waste (MSW) to 97 million tons until December 2001.

Responsibilities for Water Quality Managements

A. Legislative Aspects

1. Law 93 /1962

The first comprehensive environmental legislation controlling disposal of wastewater in the Nile and canals is Law 93 which put into force in 1962. However, the regulations and standards set were not applied to the public sector of industries. Out of fear of hindering industrial development, the inspection was discouraged, and the rules were not enforced.

2. Law 48/1982 and Decree 8/1983

Law 48 of 1982 specifically deals with discharges to water bodies. This law prohibits discharge to the River Nile, irrigation canals, drains, lakes and groundwater without a license issued by the MWRI. Licenses can be issued as long as the effluents meet the standards of the laws. The license includes both the quantity and quality that is permitted to be discharged. Discharging without a license can result in a fine. Licenses may be withdrawn in case of failure to immediately reduce discharge, in case of pollution danger, or failure to install appropriate treatment within a period of three months.

Under the law, the Ministry of Interior has police power while the Ministry of Health and Population is the organization responsible to give binding advice on water quality standards and to monitor effluents/discharges. Law 48 does not cover ambient quality monitoring of receiving water bodies although some standards are given.

Law 48 recognizes three categories of water body function:
* Fresh water bodies for the Nile River and irrigation canals;
* Non-fresh or brackish water bodies for drains, lakes and ponds;
* Groundwater aquifers.

Ambient quality standards are given for water resources which are intended as raw water supplies for drinking water. The implementing Decree 8 of 1983 specifies the water quality standards for the following categories:

*The Nile River and canals into which discharges are licensed (article 60);
*Treated industrial discharges to the Nile River, canals and groundwater;
- Upstream and downstream the Delta barrages discharging more than
  100 m^3 /day (article 61);
- Upstream and downstream the Delta barrages discharging less than
  100 m^3 /day (article 62);

*Drain water to be mixed with the Nile River or canal waters (article
65);
*Treated industrial and sanitary waste discharges to drains, lakes ponds
(article 66);
*The drains, lakes and ponds into which discharges are licensed (article
68);

Discharge of treated sanitary effluents to the Nile River and canals is not allowed at all (article 63) and any discharge of sanitary waste into other water bodies be chlorinated (article 67). The water quality standards are generally based on the drinking water standards and are not linked to all other functions a water body may have. The use of agrochemicals for is also regulated in the law.

3. Law 4/1994

Law 4/ 1994 for the environment places an emphasis on the protection of the coastal waters and the marine environment, complementing Law 48/ 1982 for the protection of the River Nile.
With respect to the pollution of the water environment, the law states that all provisions of Law 48/1982 are not affected and further, Law 4 only covers coastal and seawater aspects. Nevertheless a number of issues are unclear:

* The MWRI remains the responsible authority for water quality and water pollution issues, although the definition of “discharge” in Law 4 specifically includes discharges to the Nile River waterways. EEAA is responsible for coordinating the pollution monitoring networks.

* In Law 4 it is stated that all facilities discharging to surface water are required to obtain a license and maintain a register indicating the impact of the establishment's activity on the environment. The register should include data on emissions, efficiency and outflow from treatment units and periodic measurements. EEAA will inspect the facilities yearly and follow-up any non-compliance. This is confusing or creating duplication because Law 48/1982 also includes certain standards for effluents with MoHP as compliance monitoring organization and only MoHP laboratory results are considered to be official. Both laws (48 & 4) create funds where fines are collected and which are used to fund monitoring and other activities. Further information on Law 4 is out of the scope of this report.

B. Institutional Framework for Water Resources Management, Quality Monitoring and Pollution Control

Several ministries and organizations are involved in water quality activities in Egypt for operational, research, monitoring and regulation purposes.

1. Ministry of Irrigation and Water Resources (MIWR)

The MWRI is formulating the national water policy to face the problem of water scarcity and water quality deterioration. The overall policy's objective is to optimize the utilization of the available conventional and non-conventional water resources to meet the socio-economic and environmental needs of the country.

Under Law 12/1984, MWRI retains the overall responsibility for the management of all water resources, including available surface water resources of the Nile system, irrigation water, drainage water and groundwater.

The MWRI is the central institution for water quality management. The main instrument for water quality management is Law 48. The MWRI is responsible to provide suitable water to all users but emphasis is put on irrigation. It has been given authority to issue licenses for domestic and industrial discharges. The responsibility to monitor compliance to these licenses through the analyses of discharges has been delegated to Ministry of Health and Population (MoHP).

Through MWRI institutes, gathered under the umbrella of the National Water Research Center (NWRC), MWRI is responsible for a number of monitoring activities, such as River Nile monitoring under Nile Research Institute (NRI), the drainage canal monitoring under Drainage Research Institute (DRI) and the groundwater monitoring under Research Institute for Groundwater (RIGW). NWRC maintaining a national water quality monitoring network and contracts portions of the monitoring activity to these institutes. NWRC also operates a database where all MWRI water quality data is consolidated. NWRC also operates modern, well equipped water quality laboratories.

1.1. Nile Research Institute (NRI)

NRI is responsible for protecting and developing the Nile River in a sustainable and scientific manner by means of: (i) monitoring water quality in the river channel and drainage systems; (ii) assessing in the enforcement of pollution control laws related to the Nile system; (ii) evaluating and assessing the impact of new developments and interventions in water quality, and (iv) operating and maintaining a database related to water quality.

NRI has been involved in water quality monitoring since 1976.

1.2. Drainage Research Institute (DRI)

Since 1980, DRI conducted discharge and salinity measurements at a number of locations in drains and adjacent irrigation canals in the Nile delta on a routine basis. The goal of the monitoring program is to obtain accurate knowledge about the quantity and quality of drainage water at the outlet of each single zone catchments and at different locations on the main drains where significant changes take place due to the addition or withdrawal of water in the drains. The collected information is mainly used to estimate the possibilities of drainage water reuse for irrigation.

2- Ministry of State for Environmental Affairs (MSEA) - Egyptian Environmental Affairs Agency (EEAA)

The protection of the water environment from pollution represents one of the important priorities of Ministry of State for Environmental affairs (MSEA) and its executive institution the Egyptian Environmental Affairs Agency (EEAA).

According to Law 4, EEAA has the enforcing authority with respect to environmental pollution except for fresh water resources. Through Law 48, the MWRI remains the enforcing authority for inland waterways.

The lines of action in this regard encompass water quality monitoring activities and initiatives, as well as pollution abatement and mitigation efforts.

Achievement and Planned Activities (Programmes):

A- Protection of the Egyptian environment including water resources can be achieved through (1) adequate treatment of wastewater; (2) adapting simple technologies of the clean nature, low-cost and effective systems for the treatment of sewage water, particularly for the small communities; and (3) developing industrial processes to minimize the wastes utilizing them as by-product and/or recycling cooling water.
In 1993, an Egyptian Environmental Information System (EEIS) was set up as an integral part of the Egyptian Environmental Affairs Agency (EEAA). A pilot project was started to concentrate on various issues related to the environmental protection problems.
EEAA staff is being prepared to enforce environmental impact assessment (EIA). Major industries have been visited in view of their non-compliance with respect to wastewater treatment. Compliance Action Plans (CAP's) are being agreed upon to obtain a grace period for compliance. In cooperation with the MWRI, an action plan was implemented to reduce industrial pollution of the Nile.

B. The National Program for Prevention of Polluted Industrial Discharge to Water Resources (1996-2008)
There are four phases; the first three phases are focusing on the Nile River and drains, while the fourth is concerned with the Mediterranean Sea (out of the scope of this report).

C. In conjunction with National Environmental Action Plan (NEAP), the year 2000/2001 has witnessed the development of a five-year action plan for MSEA and EEAA. The plan comprises 14 programs reflecting the priorities of the MSEA and EEAA, and incorporating current initiatives, thus ensuring their sustainability. The plan specifies the policy measures to be achieved through each of the 14 programs, as well as the projects to be implemented, together with the necessary legislative developments and the different participating ministries, authorities and organizations, both public and private.

The NEAP includes a program on "Protection of River Nile and Water Resources". The main objective of this program is to improve quality of water resources by controlling industrial waste. Environmental education, training and awareness are included in another program concerned with increase of public awareness with environmental problems and develop human resources within the field of environment. Promotion the use of environmentally friendly technology in all economic activities is the third program in the NEAP in order to eliminate the pollution burden on water resources.

D- EEAA monitoring program for waste from Nile ships and coastal water monitoring.
During 2000/2001, four docking stations for receiving wastes from Nile cruise_boats became operational. The stations are located in Cairo, El Minya, Assuit, and Souhag. Another station located in Aswan has been constructed, and efforts are underway for putting it into operation. In conjunction with this, standards and specifications were prepared for the construction of new cruise docking stations along the Nile.

E. The Environmental Inspection Unit (EIU) is charged with monitoring 550 industries that discharge wastewater to waterways. They verify compliance with the Law 48 and the terms of their discharge license. A comprehensive database of these industries is maintained by the EIU.

F. Activities on monitoring the river water quality:
F. 1. The Environmental Information and Monitoring Program (EIMP) aims at establishing national environmental monitoring program for ambient air and coastal waters.
Two reference laboratories (water and air) are established to assist contracted national monitoring institutions in the development of quality assurance systems. EEAA expect an environmental quality data and data base as output from the program which form an integral part of EEAA's Environmental Information Center. The program, which started in January 1996, was originally a five-year program.
A DANIDA review mission visited the EIMP in October 1997 and recommended that the program was extended with three and half year.
Till now the EEAA Water Laboratory not yet certified as reference Lab.

The activities of both laboratories, as defined by EEAA, are:

- Training for monitoring institutions in quality assurance issues.
- Audits on behalf of EEAA/EIMP at monitoring institutions.
- Proficiency tests to provide information on laboratory and method performance.
- Calibration and verification of calibration of air monitoring equipment as a tool for equipment quality assurance.

F. 2. The Environmental Monitoring Training Project (EMTP)
Within the Environmental Monitoring Training Project with Japan International Cooperation Agency (JICA), which begins in 1999 and consists of sampling on an annual basis, the third study on Water Quality of The River Nile has been carried out in 2001. The main objective of the EMTP is to enhance human resource development vital to the designated target groups within the organization of the EEAA by transferring environmental monitoring and measurement technologies based on Japanese experience.

G. The Protection of Lakes Program:
Development activities along lakes and surface water bodies in Egypt have accelerated at an increasing pace during recent years. This has rendered the need for the incorporation of the environmental dimension in these developmental activities an urgent need, aiming at sustainable management of these resources. In this respect, an integrated management system for lakes in Egypt was developed, where standards and specifications for further developmental activities would ensure their protection from environmental damage.
Within the overall framework of the protection of lakes from pollution, a demonstration initiative concerned with the establishment of engineered wetlands for the treatment of wastewater from the Bahr El-Baqar drain before it enters lake El-Manzala was progressed further in 2000/2001, with its construction phase underway.

3- Ministry of Health and Population (MoHP)

The MoHP is the main organization charged with the safeguarding drinking water quality and is responsible for public health in general. Within the framework of Law 48/1982, MoHP is involved in standard setting and compliance monitoring of wastewater discharges. The MoHP monitors the discharge from major wastewater treatment plants on a quarterly basis. The program includes 96 of the 104 operating plants throughout Egypt. The results of this program are transmitted to MWRI immediately after each quarterly survey is complete. The majority of the 86 plants are non-compliant with the requirements of Law 48.

The Central Laboratories of Ministry of Health and Population undertake monitoring for all intakes and treated outflows, including wells of drinking water treatment plants with the objective of ensuring that all such treatment plants in Egypt meet drinking water standards. This program does not have a direct bearing on this study and will not be discussed further.

The Environmental Health Department (EHD), the Environmental Monitoring and Occupational Health Studies Center conduct an industrial discharge monitoring program jointly with MWRI. MWRI and the Egyptian Public Authority for Drainage Projects (EPADP) notifies MOHP of industrial discharge licenses as they as approved and issued. MOHP adds each new license to its monitoring database. Licensed industrial dischargers are monitored quarterly to ensure they meet the terms of Law 48 and their license.

Beside the aforementioned program, the Environmental Monitoring Center with its stations in the Egyptian governorates, in cooperation with EEAA, are responsible for samples collection and monitoring the River Nile and its branches since 1988.

4- Ministry of Housing, Utilities and New Communities (MHINC)

Within the Ministry of Housing, Utilities and New Communities, the National Organization for Potable Water and Sanitary Drainage (NOPWASD) has the responsibility for planning, design and construction of municipal drinking water treatment plants, distribution systems, sewerage systems, and municipal wastewater treatment plants. Once the facilities have been installed, NOPWASD organizes training and then transfers the responsibilities for operation and maintenance to the regional or local authorities.
Also MHINC issues standards and safe procedures for industrial, commercial and other work places, which are implemented by the inspectors of the Ministry of Manpower. It regulates matters related to controlling the disposal and treatment of domestic wastewater and matters related to the formulation of standards and regulations regarding the maintenance and management of the sewerage

system's back-end treatment plants as well as the implementation of such regulations from an environmental conservation point of view.

5- Ministry of Agriculture and Land Reclamation (MALR)

MALR is in charge of water distribution at field level and reclamation of new agricultural land. With respect to water quality management issues, their policies on the use and subsidy reduction of fertilizers and pesticides is important.
The Soil, Water and Environment Research Institute (SWRI) is part of the Agricultural Research Center, MALR is responsible for research on water, drainage water and soil quality, pollution, bioconversion of agricultural wastes, reuse of sewage wastewater for irrigation, fertilizer and pesticide use and effects.

6- Ministry of Industry (MOI)

Within the MOI, the General Organization for Industrialization (GOFI) manages the publicity owned facilities. GOFI manages approximately 300 industrial facilities. MOI maintains a register of all industries in Egypt including design data related to processes used and quantities of water taken in and waste discharges by each facility.

7- Ministry of Higher Education and Scientific Research (MHESR)- Academy of Scientific Research and Technology (ASRT)

Two research institutes namely the National Research Center (NRC) and the National Institute for Oceanography and Fisheries (NIOF), through research projects have some activities concerning River Nile water quality.
Through a collaborative program between "Water Pollution Control Department", as a part of National Research Center (NRC); Academy for Scientific Research and Technology (ASRT), and Michigan University in USA, a study on the River Nile water quality changes after the construction of the High dam had been conducted in the period 1973-1978.The study was sponsored by Michigan University and U. S. Environmental Protection Agency.
Another valuable monitoring study has been conducted in the same laboratory during the period 1999-2001 by a research team with a

fund from NRC on the River Nile (one site in Cairo) and eight sites on Ismailia Canal.

8- The General Organization for Greater Cairo Water Supply (GOGCWS) (Foustat Central Quality Laboratory**)**

The GOGCWS is one of the largest water authorities in Africa and middle east regarding water output, lengths of networks and the served area including main trunk and population as well as quality of water where finished water amount reaches 5.5 million m^3/day used by 16 millions, they are the inhabitants of Cairo, urban part of Giza governorate and Shoubra El Kheima City.
The GOGWCS produces potable water complying with world health specifications according to reports of the Ministry of Health and Population & international Institutions concerned with man's health.

The main responsibilities of the GOGCWS are:
* Operating and maintaining water treatment plants, developing existing plants and constructing new ones.
- Operating and maintaining master and branch distribution water mains as well as replacing worn-out mains and constructing new ones.
- Operating and maintaining water reservoirs to be used in the peaking capability time also constructing and operating posters to get over water level differences.
- Constructing and updating labs in plants which control quality and ensuring they are pollutants-free in accordance with world health standards.

This is done through 13 water treatment plants, in Greater Cairo, producing total output 5.5 million m^3 / day.

Quality Control
In each plant there's a lab performing tests on treated water so as to be good for drinking as well as monitoring it in the main till it reach the consumers conforming to the standards of the Egyptian Ministry of Health and Population.
The GOGCWS has the largest central lab in the Middle East for water analysis, it was built with 25 million L.E cost as a grant from USAID.
It analyses and monitor water sources with most accurate modern computerized equipments. The GOBCWS has also three more labs for measuring different types of pollutants and treating them at once.

The 1st lab is concerned with detecting any pollutants whether agriculture or insecticides as well as measuring the ratio of heavy metals of its all sorts. The 2nd lab, it's the microbiological one concerned with detecting bacteria, fungi and algae. The 3rd lab, for designating effective ratio of chlorine doses and other materials added to raw water to clean its impurities. The central lab performs tests for all plants related to the GOGCWS. Moreover it extends assistance to all Egypt provinces and testing samples from Aswan till Alexandria.

9- Ministry of Interior

The Ministry of Interior, Egypt's national police force, has for some time
maintained the Inland Water Police, a special police force for enforcement of Law 48 and protection of the environment.

Egypt's Efforts towards Management of Agricultural Water Demands

Egypt's agricultural sector is unique in that over 95 % of its agricultural production is derived from irrigated land and its irrigation waters originate outside of its borders.
On the macro level, the last two centuries of modern Egypt have witnessed considerable development starting by the construction of the Delta Barrage (1898) to assure summer cotton irrigation in the Nile Delta, and the establishment of an intensive canal networks for irrigation and ending by the construction of the Aswan High Dam in the sixties of the nineteenth century.
The high Aswan Dam was constructed to assure the long term availability of water for both Egypt and Sudan; however, the average annual flow during the last decade has been slightly decreased than the long term average.

A. Water Supply and Demand

A.1 Water Supply

The Nile system below Aswan can be considered a closed system with a single input from the High Aswan Dam and five outlets, which are: Evaportranspiration, evaporation, agricultural drainage water to the sea, non-recoverable municipal and industrial consumptions, and non recoverable inland navigation water released to the sea. Using this concept, the valley and Delta groundwater extractions and drainage reuse would be considered as internal mechanisms to increase the system overall efficiency and not as added resources.

The exact nature and details of these inter-relations are not clear yet. A new factor that adds to the complexity of the issue is the water quality changes.

A.2. Water Demands

Agriculture is the largest water user in Egypt. It is essentially dependent upon irrigation, and consumes the bulk of the available water (about 84 %). The future expansion programs in the cultivated area depend very much on the availability of additional water resources.
Surface irrigation systems are used in most old agricultural lands of Egypt, with an application efficiency which is still considered low. Excess irrigation water applications contribute to the groundwater shallow aquifer and to water logging problems. Water pumped from such aquifers or re-used through re-cycling of agricultural drainage water brings up the overall water use efficiency to a reasonable value (7580 %).

The Ministry of Public Works and Water Resources (MPWWR) does not give any irrigation permits for new lands, within the program of land reclamation, unless evidence is given that modern irrigation systems will be used.

Present annual municipal, industrial and navigational water demands amounts to 3.1, 4.6, and 1.8 billion m^3 respectively. In the year 1995-1996 the MPWWR has succeeded to bring navigational water use to 0.3 billion m^3 following the construction of New Esna Barrages and through changing the operating rules of winter closure period. Future requirements in such demands depend very much on population growth.

B. Water Policy

Preparation of **water policies** for Egypt dates back to 1933 when a policy was set up to make use of additional capacity due to the second heightening of the old Aswan Dam. According to the new targets in planning, the Egyptian water policies have been updated in 2004.

Water quality and quantity is undoubtedly one of the challenges which face the international community in general and the developing countries in particular. This is highlighted by the population increase and consequently by increasing development activities at all levels. The United Nations stats indicate a six fold increase in water consumption, on the world base, between “1900-1995”. The stats show that one third of world population living now in countries suffering by one way or another from water shortage. More than one milliard does not

have access to safe drinking water. Substandard water causes 80% of the diseases in the developing countries. More than four Milliard people do not have sewerage system.
Water quantities across the world vary drastically from place to place. While some rainy places have plenty of water, others are deserts suffering drought and lack water, including Egypt. Added to this are the problems which may arise among countries that shared in water basins, where pollution problems showed negative impact on water as well as environmental resources, public health and finally problems resulting from the misuse of water and drainage water resources.
Egypt is not isolated from the world, therefore water issue is one of the most pressing issues and challenges facing the Egyptian community at the beginning of third millennium, therefore the planers should direct their aims towards having a long term plan to ensure enough water resources to meet the requirements of different sectors.
Naturally, there are some circumstances and facts which affect directly the future of water resources in Egypt, most important of which are:
* The River Nile is the main water supply in Egypt representing more than 95% of all water resources in Egypt with 9 other countries sharing its water and has their own rights.
* Irrigated agriculture is the major in Egypt, consuming 85% of all water resources.
* Increasing the population with a rate of 1.3 million annually highlights the importance of developing and maximizing the use of water resources, conserving them and avoiding pollution.
* Raising consciousness for the quality of water and the necessity of taking this into consideration during the process of drawing and implementation of water strategies.
* Egypt have adopted the open market policy and this requires revising the cost of developing water resources and their revenue as well as the means of availing required fund and the involvement of the private sector.

The Ministry of Irrigation and Water Resources (MIWR) has planned a water strategy scientifically and subjectively based taking into consideration all economic and social changes as well as all alternatives to realize the necessary dynamics, elasticity and the possible solutions to meet the present and future water demands for all sectors and development activities required to achieve stability and progress headed by the implementation of horizontal expansion projects aiming the reclamation and cultivation of 3.4 million Feddans by 2017 including 540,000 Feddans in South of the Valley development project and 620,000 Feddans in North Sinai development project in addition to 2.2 million Feddans across the country out of which 1.5 million Feddan allocated to Upper Egypt. The most important aspect of this water strategy till 2017 is to achieve the best use of the available water resources and maximizing the benefit from them, maintaining the quality of water, eliminating pollution and regional co-operation with the Nile Basin countries. This could be achieved through the implementation of various activities some of which are:

1- One of the most important national programs implemented by the MIWR aiming at developing 3.5 million Feddan by the end of 2017 resulting in maximizing the benefits of irrigation water to meet the needs of future expansions through developing irrigation network, changing the irrigation system from alternating to continuous and the formation of federations and councils for those who use water (6000 federation – 12 councils). This will help towards the contribution of the beneficiaries in operating the canals, their maintenance, distribution of water and minimizing the percentage of wastes, all of which will contribute in the fair distribution of water to reach the fields at a suitable time with enough quantities to meet the requirements of the plants. The result is raising the efficiency of field irrigation and the spreading of modern irrigation systems in the horizontal expansion projects in the new lands, leaving a surplus in irrigation water estimated at about 3 – 4 milliard m^3 annually.

2. Agriculture drainage water mixed with Nile water is being increasingly re-used in agriculture and estimated by 5 milliard m^3 at present to 8.4 milliard m^3 /year by 2017. Treated sanitary wastewater (sewage) is also being increasingly used as 0.7 – 2.0 milliard m^3 /year in irrigating woods in a sound and safe environmental frame. There is also an expansion in desalination of sea water especially in distant areas where industrial and touristic projects are being increased (150 million m^3 / year at present).

3. In the field of controlling pollution sources due to their dangerous impact on all national programs:

A ministerial committee has been formed to intensify and co-ordinate the efforts of other ministries and concerned departments. This committee will deal with water pollution and suggest remedial procedures which will include treatment of industrial wastes, domestic wastewater (sewage) projects, reinforcing the networks for monitoring and control water quality and covering canals and agricultural drains through three plans, five years each, at a cost totaling 10.3 milliard Egyptian Pound till the year 2017 and implemented gradually according to priorities which are directly related to the main Nile.

This apart from the ministry's various achieves to minimize pollution and preserve the environment through establishing a network for water quality monitoring and control including 290 location for surface water and 200 control point for underground water. Establishing a completed laboratory to monitor water quality according to the most recent international standards for issuing analyses, chemical and physical tests, is essential. Water courses inside highly populated areas are being covered. Laws for preserving the Nile and other water courses are enforced to protect them from pollution and abuse. Using chemicals for fighting water plants is prohibited.

4. In the field of co-operating with Nile Basin Initiative to develop new water resources:
This could be achieved through the new machinery for co-operation with Nile Basin Initiative (NBI) to implement various joint projects based on the principle of benefit for all supported by the World Bank and various other international grantors organization. These joint projects have been approved and 140 million dollars have been allocated for the first stage of the studies.

For future (after year 2017) strategic studies are being prepared based on regional and nationals levels

a) On the Regional Level:

1- Working with the Nile Basin Countries through the machinery of the Nile Basin Initiative to implement upper Nile projects which have priority aiming at minimizing waste and increase river expenditure for the benefit of the basin countries. The most important of these projects is the Blue Nile tributaries (Baro-Acobo) to avail 12 milliard m^3 for the benefit of Ethiopia, Sudan and Egypt.

2- Taking measures aiming at studying, developing and managing Nubian sandstone reservoir which is considered one of the largest underground water reservoirs in the whole world in co-operation with the countries sharing this reservoir with Egypt.

3- Considering the establishment of joint agricultural projects together with the countries of the Nile Basin or other African countries.

b) On the National Level

1- Developing underground water resources, subsurface and deep, by intensifying the implementation of a network of wells in the valley, the Delta, Western Desert and Sinai in addition to making use of semi-salty underground water.

2- Desalination of sea water and wastewater as this is a promising water source especially in distant areas where touristic and industrial projects are increasing. The strategic studies unit in the MIWR is trying to identify Egypt's requirements from these sources, their timing and cost.

3- Minimizing evaporation at Lake Nasser by closing some major Khours like Kalapsha and Allaqy, changing the rules of operating the High Dam and investigating possible effects on increasing the live capacity of the lake.
4- Storing surplus flood water in eastern valleys to be used in the industrial and touristic communities along the Red Sea coast as well as filling the underground stress in these areas.
5- Developing water resources allocations percentages for various sectors by redirecting a tiny percentage from agriculture to avail the requirements for drinking water and industry. This policy would be adopted by introducing new agricultural types which consumes less water or using water of inferior quality.

Summary of Potential Measures

OPTIMUM USE OF WATER

Operational management Nile water system

- Changes in Lake Nasser reservoir operation, in combination with conjunctive use of surface and groundwater
- Improved seasonal water allocation to different irrigation districts based on proposed cropping patterns and available water

Water use in municipal and industrial sectors

- Reduction of leakage losses in distribution systems
- Demand management

Water use in agriculture

- Improvement of irrigation efficiencies
- Increase irrigation effectiveness by using more water-use efficient crop varieties
- Irrigation improvement at mesqa level through IIP
- Reuse of drainage water
- Horizontal expansion in addition to assumed Reference Case expansion;
- Use of irrigation water for aquaculture
- Demand management

DEVELOPMENT OF POTENTIAL WATER RESOURCES

Groundwater development in various regions

Rainfall harvesting and artificial recharge using flash floods

Desalination of brackish water and sea water

IMPROVEMENT OF PUBLIC HEALTH AND ENVIRONMENTAL CONDITIONS

Public health and pollution control

- Provision of safe drinking water and protection of drinking water sources
- Provision of affordable/suitable sanitary facilities

- Avoidance of contact with polluted water and enforcement of standards/regulations for the quality of agricultural products and fish that may have been affected by polluted water
- Domestic pollution: provision of sewerage systems or collection stations for vacuum trucks (in rural areas) and treatment facilities
- Industrial pollution: reduction of pollution loads through incentives, taxation, enforcement of laws and regulations and waste water treatment, and concentration of polluting industries away from sensitive water systems
- Agricultural pollution: reduction of pollution loads through incentives, law enforcement with respect to harmful pesticides, and/or switching pesticide extension from manufacturers to EEAA
- Create tradeable pollution rights

Protection of environmentally important areas

Protection of coastal lakes and recognition of certain areas as protected area or nature reserve

Operational management

- Operation of a monitoring system that provides information on the status and development of the environment
- Operation of an emission registration that keeps track of existing emissions and their characteristics

PUBLIC AWARENESS PROGRAMMES

- Use of water: to avoid wasting water at home and over-irrigation by farmers
- Public health: aimed at using safe water, to practice safe irrigation techniques or use proper precautions
- Environment awareness programs
- Industrial pollution: aimed at the production and consumption of clean products
- Agricultural pollution: aimed at environmentally friendly production methods in agriculture (e.g. integrated pest management)

C. Present and Future Programs for Managing Demands for Agricultural Users

The National Water Research Center (NWRC) has carried out a detailed study (1977-1984) to identify the major constraints that hinder the efficient use of water for irrigation, and to propose a **water management** strategy for Egypt. The principal constraints were found as follows:

- Fragmentation of land into small and separate holdings has limited the establishment of efficient irrigation methods.
- Misuse of canal banks, degradation and sedimentation has contributed to changes in water levels and canal discharges.
- The use of the rotation system has its limitation for better water control and use of modern irrigation systems.
- The lack of an efficient water extension service.

- Excessive looses from the irrigation system between main points of distribution and farm outlets.
- Diversity of crops within area as served by one canal.
- Abundance of night irrigation.
- Poor land leveling.
- Lack of adequate funds for maintenance and the absence of a charging or cost recovery system which would provide funds for that purpose.

With limited renewable fresh water resources and a continuous increase in water demands for agriculture, the issue of satisfying such demands becomes very serious. The per capita water share of fresh water resources is expected to drop from a current value of about 930 m^3/year to about 350 m^3 by the year 2025. Based on present lessons and constraints, the country has to implement rigorously several management programs. The realization of these programs will require considerable commitment from policy makers, technicians and water users.

The existing demand management programs have two dimensions. The first deals with the hardware of the system and the second with the software part. Each is implemented on the different levels of the system: macro, meso and micro, mostly in areas related to policy, management, planning, design control, operation maintenance and institutional issues.

The identified constraints of the demand management as well as improvement in the performance of the Nile system **(IMS) programs** which has 10 project components:

1. Regional Irrigation Improvement Project (RIIP).
2. Structural Replacement.
3. Preventive Maintenance.
4. Main System Management (Telemetry).
5. Planning Studies and Models.
6. Professional Development.
7. Research and Development (National Water Research Center).
8. Project Preparation.
9. Survey and Mapping.
10. Miscellaneous TA and Commodity Procurement.

These 10 components involve a large number of participating departments: agencies, and farmers.

In the following, the main features of some of the important components are presented.

The Regional Irrigation Improvement Project (RIIP)

The RIIP is to establish and field test an organizational structure within MWRI capable of providing technical assistance, construction assistance, economic analysis, on-farm development assistance, and user involvement to remodel selected irrigation canal commands.
The objective is to make the system more responsive to the needs of farmers and to assure that water is available in the quantities required at the time it is needed to support increased agricultural output.

In 1984 a National Program for irrigation improvement had been approved. The program started in an area of 40.000 acres forming the first phase of the RIIP. The plan of 1992/97 covers an additional area of 350.000 acres with an estimated cost of 120 million $.

Establishment of farmer organizations and irrigation advisory services were found necessary for the success of the program and for the future operation and maintenance of the farm irrigation systems.

The Project is forming water users association (WUA) and implementing advisory service (IAS). Both of these concepts have been identified and successfully tested under the Egypt water use and management project 1977-1984 (EWUP) on a pilot basis. They are now being implemented on a large scale.

The improvement and modernization works vary from realignment of water courses and distributor canals with reconstruction of their section to lining and use of elevated pre-cast water courses or use of buried pipeline system. The present average cost/acre is around 500$ which will bring up the total cost to cover the presently cultivated old land of about 6 million acres to 3 billion $. The expected saving of water is between 1015 % with an average increase in agricultural productivity of 30 %.

Because of the time and high investment requirements a crash program that deals with some control structure was initiated (SR).

Structural Replacement (SR)

The SR component is aimed at the smaller structures in the irrigation system-intake regulators, head regulators, weirs, tail escapes, spillways, bridges and crossing structures. It is also aimed at improving the quality of structures and assuring that they are built up to MWRI specifications.

This program was completed by the end of 1994 covering about twenty thousand structures.

Preventive Maintenance

Preventive maintenance is being carried out in some selected irrigation directorates and is to install the procedures to plan for, manage, and control higher levels of maintenance.

The end result of this program is a preventive maintenance program, tested, accepted, functional, and fully staffed in at least six directorates.

Main System Management (Telemetry)

Management decisions to increase or diminish water flows at key points throughout the irrigation delivery system are improved by a telemetry data collection system. This system is now providing real time data to the managers of the system resulting in improved management and reduction of waste and irrigation shortages.

The **telemetry system** is to provide detailed data (water level, flow rates, water quality) and communications in some specific points in the irrigation system. Data are assembled utilizing meteor burst transmission of collected data to computerized stations at both Cairo and Aswan. This appropriate technology was selected because of its low cost, and its relatively simple operation and maintenance requirements.

Planning Studies and Models

The MWRI through its water planning group (WPG) has developed a number of computer models that are designed to increase the operating efficiency of the whole system. These models fall into two groups:
one group concerns in flow simulation to predict flows into Lake Nasser from the area above the lake, i.e. the basic source of water supply. This group also concerns the operating rules of the high Aswan Dam (HAD), i.e. how stored water supply is to be released in accordance with power, navigation, irrigation and other needs.
The other group of models is concerned with the service area between the HAD and the Mediterranean Sea. They are used to analyze the impact of the water delivery system on agricultural policy programs, and vice-versa; plan the distribution of water through the system; and provide detailed operating parameters, such as gate movement schedules for

operating the system within a specified set of system operating constraints.

Professional Development

This component institutionalizes a multi-disciplinary training program to serve the total manpower training development requirements of the MWRI. The National Irrigation Training Institute (NITI) concept was found to be the best cost alternative to meet the MWRI training needs. The Institute is completed and is ready to serve Egypt and the Region.

The National Water Research Center (Research & Development)

The scope and complexity of the MWRI responsibilities for the irrigation system involves a wide range of scientific disciplines and widely varying subject matter areas. The main objective of the NWRC is to carry basic research and to be the reservoir of knowledge on all aspects of the irrigation system. To serve this purpose, eleven research institutes are fully operational. The NNWRC and its institutes are to support all the sectors and the authorities of the MWRI in many areas starting from decision making, technology transfer planning, modernization …. etc., and ending at helping in solving day operational problems of the system.

Fresh Water Saving Program

The second feasible water management program is through the minimizing of fresh water spilling to sea mainly during the closure period. Through the construction of the new Nag-Hammadi navigation lock, the construction of New Esna barrage, and the improvement of the river navigable channel, the spilling of fresh water to the sea is restricted to 70 million m^3/day during the closure period of about 3 weeks every year. This minimum discharge is necessary to provide intake levels for municipal water supply pumps along the river course and to satisfy municipal and industrial water requirements. An annual amount of 1.5 X 10^9 m^3 from the total spilling estimated at 1.8 X 10^9 m^3 annually is proposed to be utilized through supplementary irrigation within the northern western coastal zone, and partial storage in the northern lakes.

Water Quality Issues

While a reasonably clear picture exists in terms of salinity of water, availability of usable information on other water quality parameters is very limited. There is an essential need for a rational water data collection and management program. Large volume of domestic and untreated industrial effluent is still discharged into the river and water channels. In addition, significant proportions of fertilizers and pesticides used are leached into the water system. Potential groundwater contamination from fertilizers in the Egypt agriculture increased nearly 4 fold during 1960-1988.

Use of pesticides has increased as well, but not at the same rate of fertilizer, in early 1991, use of herbicides to control aquatic weeds in Egypt was stopped.

Increasing water pollution from industrial and domestic sources, if allowed to grow unchecked, is likely to reduce the amount of water available for various uses in the future.

. Strategic Research

Egypt now faces challenges to satisfy future water demands that could coop with development requirements and environmental issues. Such challenges would require not only long tern planning, but also the consideration of the interlinkages between technical, economical, social and environmental issue. A new Strategic Research Unit within the NWRC was established and a Strategic Research Program was proposed.

The activities of such program, which is composed of four components, are listed as follows:
Component 1: Increasing the Global Efficiency of the Nile Irrigation System
Component 2: Reclamatation and Reuse of Brackish and Polluted Waters
Component 3: Augmentation by Exploiting Deep Aquifers in the Desert
Component 4: Utilization of Conserved and Augmented Water

Multi-criteria, Multi-disciplinary model has been developed by the strategic Research Until as an integrated Water Resources model for sustainable development of Egypt.

The model addresses many issues of which are, demand management, water allocation, conjunctive use, water conservation, risk assessment and social, environmental and economic impacts. Research in areas such as these will undeniably make a significant contribution towards the formulation of a strategic Water Development Plan for Egypt.

D. Reuse of Agricultural Drainage Water

The amount of agricultural drainage water presently re-used in irrigation is 5.0 billion m^3 annually of which 4.0 billion m^3 in the Nile Delta, 1.0 in Fayoum in addition to the return flow to the Nile from the Upper Egypt drainage system. This re-used drainage water in the Delta reached about 5 BCM/ year by year 2000 and expected to reach 9 BCM by year 2017. The total annual volume of agricultural drainage water for the year 1993 amounts to 12 billion m^3, which varies in both quantity and quality with time of the year and location. It is to be noted that part of this water is from industrial and municipal waste discharge to the drainage system. Within the northern part of the delta, where most of drainage pumping stations exists, considerable contribution to the drainage system comes from upward seepage of saline groundwater.
Several studies carried out by NWRC institutes confirmed this observation.

The debate on the extent the country should depend on in the policy of agricultural drainage wastewater is strongly affected by the following facts;

a. The potential savings from improved water management, and increasing water re-use are not mutually exclusive. There is a real danger that the salinity of drainage water could increase steadily over the years. Thus, a cautious approach to increasing the use of drainage water, especially in terms of water quality, is likely to be the long tern interest of the country.

b. The total salt balance of the Nile Delta requires continuous leaching. This is evident when comparing a total salt load within the irrigation water to the Delta of about 18 million tons with a total salt load of 31 million tons with the drainage water pumped out of the Delta.

c. Salt water intrusion will increase from the sea to the northern delta if serious reduction of the net deep percolation in the irrigated area takes place.

The scenario adopted by the MPWWR is to move carefully in the two national programs i.e. water management and improvement of the irrigation system and the agricultural drainage water re-use program within the 7.7 billion m^3 figure.

E. Re-use of Treated Municipal Wastewater

The first use of treated wastewater in Egypt was in 1915 in the eastern desert north east of Cairo. An area of 2500 acres is still under irrigation with wastewater which receives only primary treatment. With the scarcity of water resource, it is planned to irrigate 150.000 acres with treated wastewater up to the year 2000.

All urban wastewater projects include facilities for treatment up to the tertiary level and allow re-use for irrigation. Many of the rural areas are still lacking such facilities. It is estimated that by the year 2000, the amount of wastewater from major cities and urban areas are as given.

Wastewater from Urban and major cities

Area	Year 1992 Billion m^3/year	Year 2000 Billion m^3/year
Cairo	1.36	1.7
Alex.	0.53	0.65
Other urban	1.54	2.58
Total	3.43	4.93

Current in Egypt, detailed Criteria for wastewater reuse in agriculture is under review and preparation. Several pilot programs have started and under continuous monitoring for some.

F. Cost Recovery of Irrigation Improved Programs

The issues of cost recovery have started receiving increased attention in Egypt. It is considered as an approach to generate additional revenue which could be used to operate and maintain irrigation system, and even repay some, or all, of the investment costs. It could help also in conserving water uses by the farmers. The effectiveness of a costs recovery policy to achieve its expected objectives is dependent on many factors among which are the system through which water consumption is measured and the relation between existing taxation and water subsidy and the proposed water charging one. Farmers reactions to such changes to the environment should be equitable generate revenue and simultaneously promote more efficient water use than is the case at present.

In July 94 the Egyptian people's assembly passed a law to charge the MPWWR to implement a cost recovery law on the Mesqa level. The same law sets the procedures to establish farmer's water users association and the irrigation advisory service. Law implementation has been stopped.

Concluding Remarks

1. Egypt being an arid country has limited water resources beside depending mainly on one single source – The River Nile.
2. It is evident now that Egypt consumes its entire share from the river to satisfy water demands for different users and for the present population. Further increase in water demands is expected by population increases.
3. Egypt has launched several demand management programs which depend on maximizing the benefits of the present fresh water resources and adopt technically and environmentally sound re-use program.
4. The inter-relations between the different components of the water balance equation are complex and continuously changing in Egypt. The water use patterns diversity of crops within the cropping pattern recycling of agricultural drainage water and pumping from shallow aquifers is becoming the concerns for formulating demand management programs.

For future agricultural uses the reuse of treated wastewater and drainage water is considered an important element water policy. Both these resources have health and environmental implications and hence a functional system of monitoring and continuous evaluation is absolutely essential. Long-term potential environmental impacts of reuse of drainage water and criteria for use should be clearly identified. Institutional and legal implications of establishing a water quality data monitoring and management system has to be prepared and implemented.

Fig. 6 COD values of Upper Egypt drains at their points of discharge into the Nile.

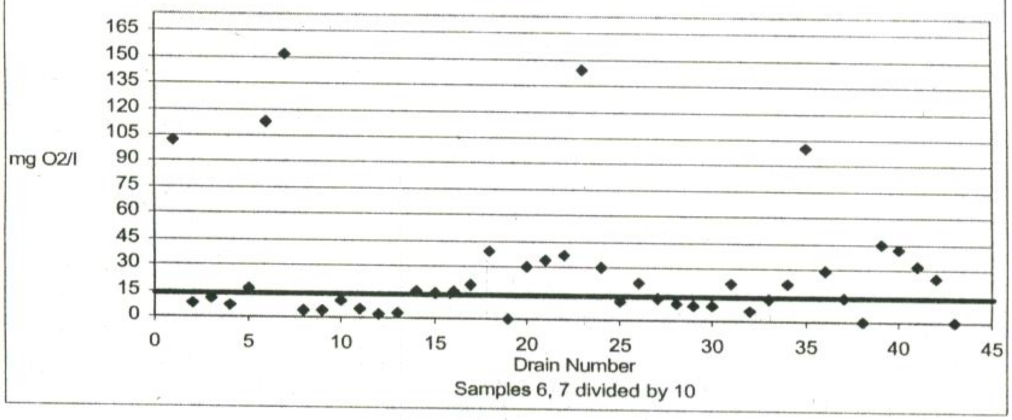


Fig. 7 : BOD values of Upper Egypt drains at their points of discharge into the Nile.

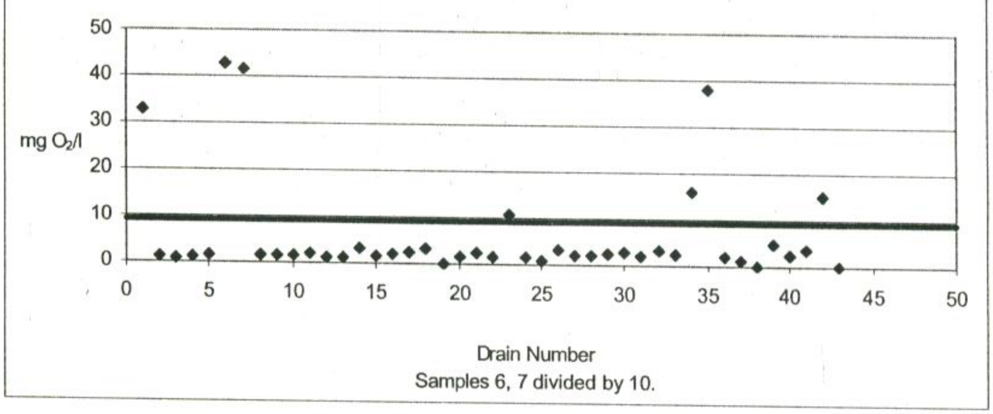


Fig. 8 : TDS values of Upper Egypt drains at their points of discharge into the Nile.

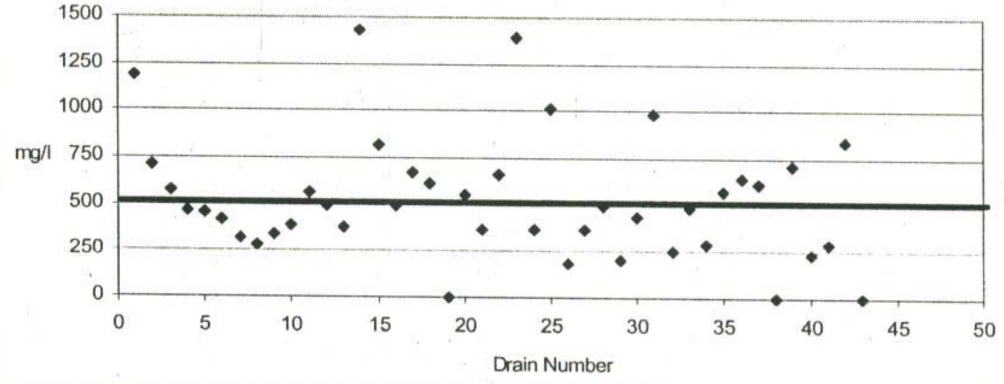


Fig. 9 : FC counts in Upper Egypt drains at their points of discharge into the Nile.

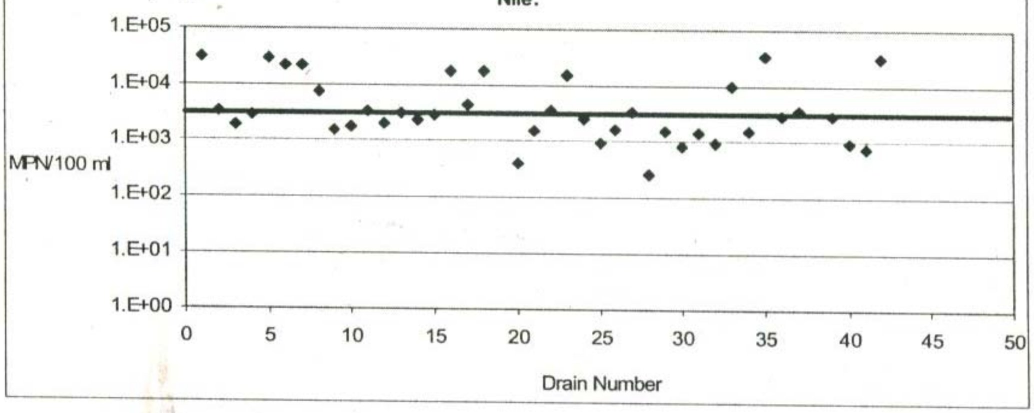


Fig. 10 DO concentrations of Upper Egypt drains at their points of discharge into the Nile.

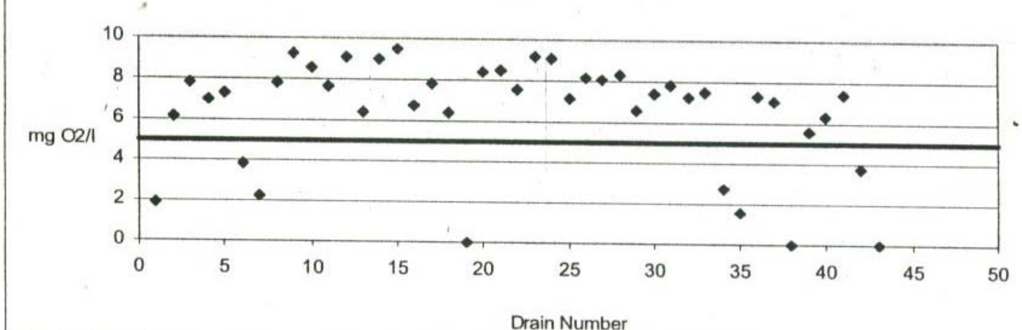


Fig. 11 : COD loads cotributed by the agricultural drains from Aswan to delta barrage .

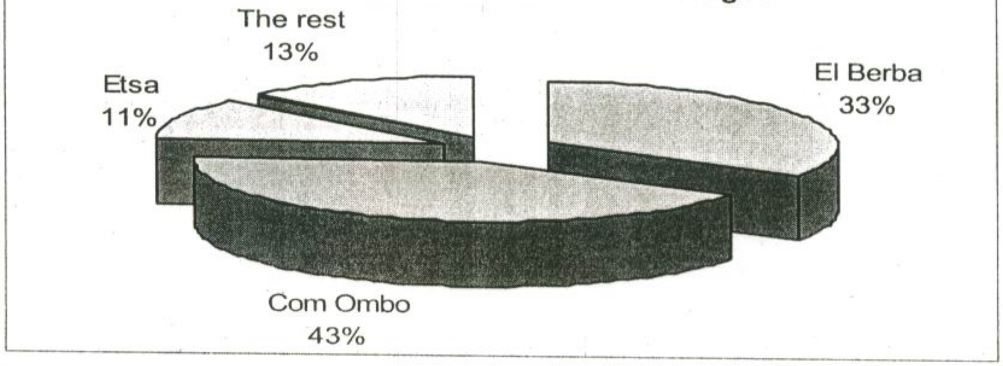


Fig. 12 : BOD loads cotributed by the agricultural drains from Aswan to delta barrage ..

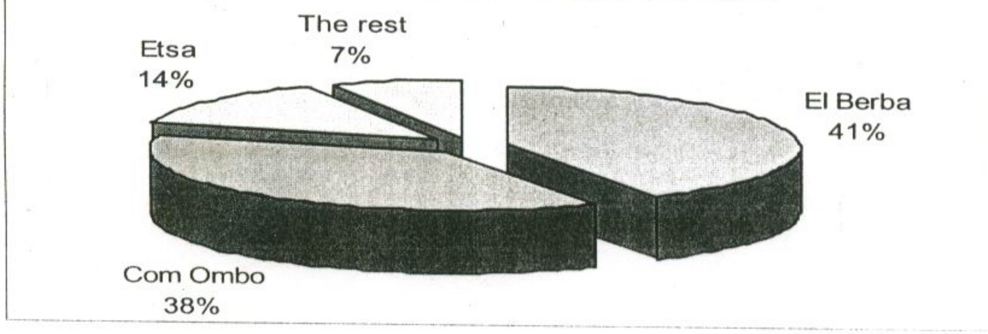


Fig. 13 Watewater discharged into Al-Bakar Drain (% Q).

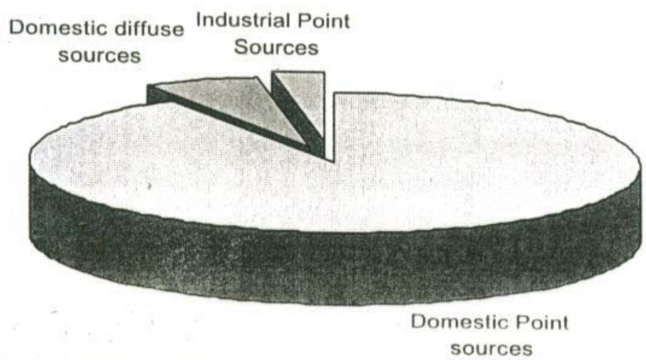


Fig. 14 : COD (%) loads received by Al-Bakar Drain.

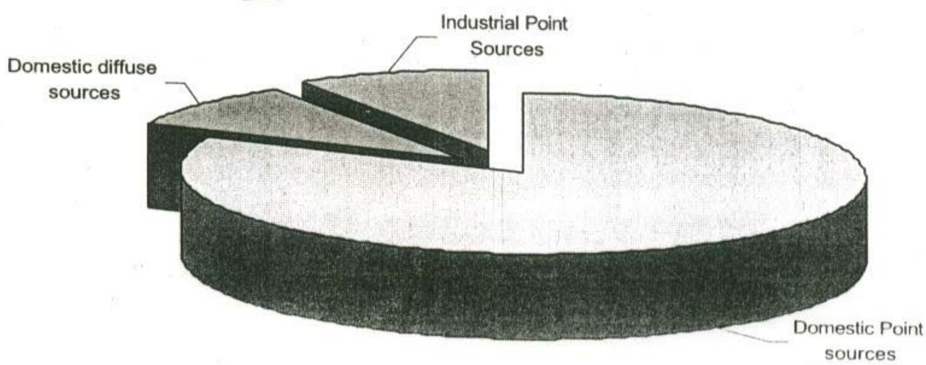


Fig. 15 BOD (%) loads received by Al-Bakar Drain.

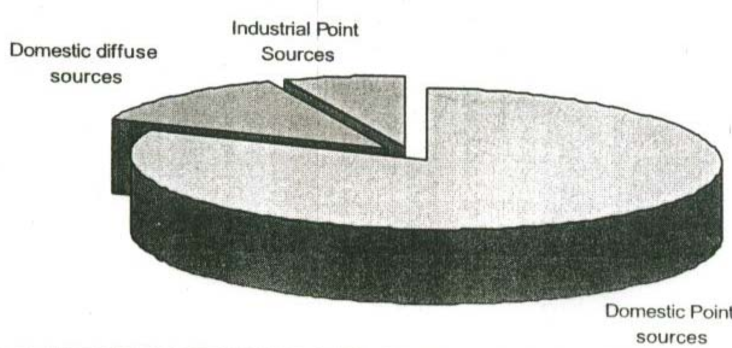


Fig. 16 SS (%) loads received by Al-Bakar Drain.

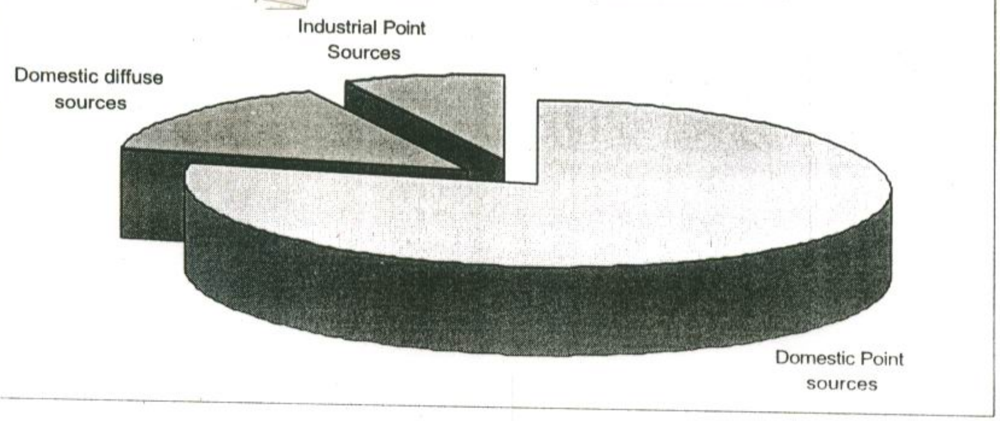
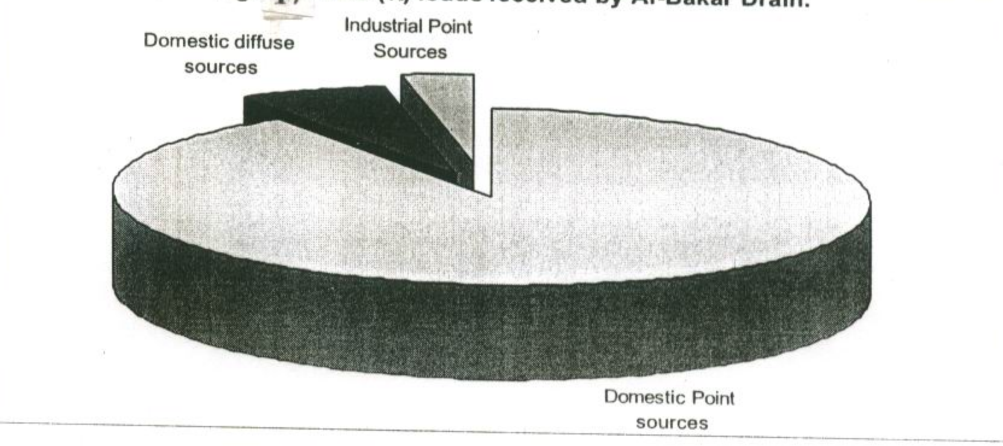


Fig. 17 TDS (%) loads received by Al-Bakar Drain.



Water Quality Assessment

1. Agricultural Drain Point Source Discharge

1.1. Source of Data

This part of the report depends mainly on:
The report entitled "Survey of Nile System Pollution Sources (Report 64, 2002) which use the NWRC (2001) survey data as reference.

1.2. Agriculture Drains from Aswan to Delta Barrage

According to the National Water Resources plan for Egypt (NWRP, 2001), the Nile River from Aswan to Delta Barrage receives wastewater discharging from 124 point sources, of which 67 are agricultural drain and the remainder are industrial sources.
Physico-chemical characteristics and fecal coliform counts of 43 major drains at the tail ends, before discharge into the River Nile are presented in Table 17. The parameters that are non-compliant with Law 48 are shown shaded in the table. The data indicates that out of the 43 drains, only 10 (demonstrated graphically in Figures 1 - 5 for selected parameters) are complying with the standards set by Law 48/1982 (article 65) regulating the quality of drainage water which can be mixed with fresh water. The worst water quality is that of Khor El-Sail Aswan, Kom Ombo, Beba and Etsa drain.

In terms of organic load, it was found that the highest organic load is discharged from Kom Ombo drain (218.1 ton COD/d; 59.7 ton BOD/d). This is followed by El-berba drain (172.7 ton COD/d; 59.7 ton BOD/d), (Table 18). These two drains contribute 76% of the total organic load (calculated as COD) discharged into the Nile by drains from Aswan to Delta Barrage. Etsa drain contributes about 11% of the total COD load (56.8 ton COD/d). Figures 6 & 7 depict this graphically.
It is important to mention here that information about water quality along the length of drains in Upper Egypt is not available.

Table 17 :Water quality of agricultural drains in Upper Egypt(NRI)

Code	Drain Name	Dis. From AHD (km)	Discharge Mm^3/day	COD mg O_2/l	BOD mg O_2/l	DO mg O_2/l	TDS mg/l	FC MPN/100ml	Heavy Metals
	Consent. Standard			15 mg/l	10 mg/l	5 mgO_2/l	500 mg/l	5.00 E+03	3
DU1	Khour El sail Aswan	9.9	0.10	102	32.80	1.91	1190	3.25E+04	0.31
DU2	El Tawansa	37.3	0.01	8	1.01	6.16	710	3.50E+03	0.50
DU3	El Ghaba	46.6	0.19	11	1.00	7.8	570	1.85E+03	0.75
DU4	Abu Wanass	47.2	0.20	7	1.28	7.03	463	3.00E+03	0.39
DU5	Main Draw	48.9	40 l/s	17	1.48	7.34	460	3.00E+04	0.61
DU6	El Berba	49.1	0.15	113	42.70	3.85	414	2.25E+04	0.70
DU7	Com Ombo	51.0	0.14	151.6	41.50	2.25	325	2.25E+04	2.15
DU8	Menaha	55.0	-	4	1.52	7.86	285	7.50E+03	0.26
DU9	Main Ekleet	57.0	0.02	4	1.53	9.21	340	1.50E+03	2.44
DU10	El Raghama	64.7	0.04	10	1.55	8.56	390	1.75E+03	0.30
DU11	Fatera	70.5	0.78	5	2.04	7.7	564	3.50E+03	0.54
DU12	Khour El Sail	70.8	0.17	2	1.05	9.07	500	2.00E+03	0.34
DU13	Selsela	73.9	50 l/s	3	1.25	6.38	380	3.20E+03	1.26
DU14	Radisia	99.9	0.13	16	3.06	9.02	1430	2.30E+03	0.22
DU15	Edfu	116.2	0.27	15	1.59	9.49	817	3.00E+03	2.37
DU16	Houd El Sebaia	139.5	0.05	16	1.83	6.77	495	1.75 E+04	0.76
DU17	Hegr El Sebaia	149.1	0.05	19	2.55	7.82	670	4.50E+03	0.51
DU18	Mataana	187.7	0.12	39	3.15	6.45	613	1.75E+04	1.29
DU19	El Zeinia	236.0	NA	NA	NA	▫	▫	▫	NA
DU20	Habil El Sharky	237.7	0.08	30	1.78	8.45	560	4.00E+02	1.06
DU21	Danfik	251.6	0.01	34	2.52	8.51	367	1.50E+03	1.05
DU22	Sheikia	265.3	0.06	37	1.72	7.55	662	3.75E+03	4.68
DU23	El Ballas	270.7	0.01	144	10.78	9.17	1395	1.50E+04	0.59
DU24	Qift	275.9	0.03	30	1.60	9.11	375	2.50E+03	0.39
DU25	Hamed	331.2	0.07	11	1.00	7.18	1015	9.00E+02	0.35
DU26	Magrour Hoe	340.4	0.06	21	3.24	8.2	185	1.60E+03	1.05
DU27	Naga Hammadie	377.8	0.21	13	2.17	8.11	375	3.30E+03	1.67
DU28	Mazata	392.8	0.01	10	2.19	8.37	495	2.50E+02	0.23
DU29	Essawia	432.7	0.07	9	2.43	6.61	200	1.50E+03	0.51
DU30	Souhag	444.6	0.05	9	2.81	7.42	440	8.00E+02	0.38
DU31	Tahta	486.4	0.01	21	2.01	7.86	980	1.40E+03	0.29
DU32	El Badary	525.4	0.12	6	3.27	7.25	255	9.00E+02	0.48
DU33	Bany Shaker	588.6	0.02	13	2.25	7.47	485	1.00E+04	0.30
DU34	El Rayamoun	637.4	NA	21	15.85	2.77	290	1.50E+03	0.16
DU35	Etsa	701.2	0.57	100	38.00	1.58	575	3.50E+04	0.19
DU36	Absoug	780.5	0.19	29	1.89	7.34	640	3.00E+03	0.34
DU37	Ahnasia	807.2	0.54	14	1.31	7.08	610	3.75E+03	0.26
DU38	El Saff	871.3	NA	NA	NA	*	*	*	NA
DU39	El Massanda	879.6	0.14	45	4.99	5.57	715	3.00E+03	0.19
DU40	Ghamaza El Soghra	884.5	0.06	42	2.52	6.37	235	9.50E+02	0.46
DU41	Ghamaza El – Kobra	885.0	0.05	32	3.79	7.39	290	7.50E+02	0.28
DU42	El Tibeen	898.1	0.02	25	15.20	3.71	840	3.25E+04	0.39
DU43	Khour Sail Badrashin	910.2	NA	NA	NA	*	*	*	NA

Shaded values are non-compliant with Law 48.

Table 18 : Loads of Organic and Inorganic Pollutants Discharged into the Nile from Upper Egypt Drains

No.	Drain Name	Location (km)	Discharge Mm^3/day	COD kg/day	BOD kg/day	Heavy metals kg/day
1	Khour El sail Aswan	9.9	0.098837	10.08137	3.241854	0.030333075
2	El Tawansa	37.25	0.006484	0.051872	0.006549	0.003245242
3	El Ghaba	46.55	0.194087	2.134957	0.194087	0.146341598
4	Abu Wanass	47.15	0.199061	1.393427	0.254798	0.078330504
5	Main Draw	48.85	0.003456	0.058752	0.005115	0.002106432
6	El Berba	49.1	0.15282	172.6866	65.25414	0.10720323
7	Com Ombo	51	0.143865	218.0993	59.70398	0.309122726
8	Menaha	55	NA	0	0	0
9	Main Ekleet	57	0.020166	0.080664	0.030854	0.049174791
10	El Raghama	64.65	0.044712	0.44712	0.069304	0.013346532
11	Fatera	70.45	0.0779492	3.89746	1.590164	0.418197458
12	Khour El sail	70.75	0.170387	0.340774	0.178906	0.058016774
13	Selsela	73.85	0.00432	0.01296	0.0054	0.005454
14	Radisia	99.85	0.1307	2.0912	0.399942	0.02908075
15	Edfu	116.2	0.2689	4.0335	0.427551	0.63742745
16	Houd El Sebaia	139.5	0.048989	0.783824	0.08965	0.037256135
17	Hegr El Sebaia	149.1	0.049541	0.941279	0.12633	0.02524114
18	Mataana	187.7	0.122499	4.777461	0.385872	0.158207459
19	El zeinia	236	NA	0	0	0
20	Habil El Sharky	237.7	0.079119	2.37357	0.140832	0.084222176
21	Danfik	251.55	0.008224	0.279616	0.020724	0.00865576
22	Sheikia	265.3	0.05983	2.21371	0.102908	0.279794995
23	El Ballas	270.7	0.006383	0.919152	0.068809	0.003788311
24	Qift	275.9	0.032637	0.97911	0.052219	0.012744749
25	Hamed	331.2	0.067068	0.737748	0.067068	0.023239062
26	Magrour Hoe	340.35	0.058709	1.232889	0.190217	0.061497678
27	Naga Hammadie	377.8	0.2149	2.7937	0.466333	0.35920535
28	Mazata	392.75	0.005868	0.05868	0.012851	0.001329102
29	Essawia	432.7	0.074202	0.667818	0.180311	0.037731717
30	Souhag	444.55	0.0475	0.4275	0.133475	0.01826375
31	Tahta	486.4	0.006276	0.131796	0.012615	0.001829454
32	El Badary	525.4	0.11994	0.71964	0.392204	0.05703147
33	Bany Shaker	588.6	0.019602	0.254826	0.044105	0.005968809
34	El Rayamoun	637.4	NA	0	0	0
35	Etsa	701.15	0.567976	56.7976	21.58309	0.105359548
36	Absoug	780.5	0.194386	5.637194	0.36739	0.066965977
37	Ahnasia	807.2	0.541652	7.583128	0.709564	0.138933738
38	El Saff	871.3	NA	0	0	0
39	El Massanda	879.6	0.14148	6.3666	0.705985	0.02624454
40	Ghamaza El Soghra	884.5	0.059616	2.503872	0.150232	0.027214704
41	Ghamaza El Kobra	884.95	0.048036	1.537152	0.182056	0.013618206
42	El Tibeen	898.1	0.02017	0.50425	0.306584	0.007795705
43	Khour Sail Badrashin	910.15	NA	0	0	0
sum				516.6321	157.8541	3.449520092

Shaded values are non-compliant with Law 48.

1.3. Agricultural Drains in the Delta

In the rural areas about half of the population (35 million) are accommodating, 95% of them have no access to sewer systems or wastewater treatment facilities. Accordingly, Delta drains mainly used for discharge of predominantly treated or poorly treated wastewater (domestic & industrial), and drainage of agricultural areas. Therefore, they contain high concentrations of various pollutants such as organic matter (BOD, COD), nutrients, fecal bacteria, heavy metals and pesticides.

The drainage water is becoming more saline; on average its salinity increased from 2400 g/m^3 in 1985 to 2750 g/m^3 in 1995. But there are local variations, ranging between 750 and 1000 g/m^3 for drainage water of the southern part of the Nile Delta, whereas in the middle parts of the Delta it reaches about 2000 g/m^3 and in the northern parts between 3500 and 6000 g/m^3 (Survey of Nile System Pollution Sources, Report No. 64, 2002).

In a study carried out by Drainage Research Institute (DRI, 2000), it has been estimated that the Delta and Fayoum drains receive about 13.5 BCM/year. Almost 89.7% of which is contributed from agricultural diffuse source, 6.2% from domestic point sources, 3.5% from domestic diffuse sources and the rest (0.5%) from industrial point sources (Table 19). Bahr El-Baqar receives the greatest part of wastewater (about 3 BCM/year). This is followed by Bahr Hadous, El-Gharbia main, Edko and El-Umoum, with an average flow of 1.75 BCM/years for each. The wastewater received by the rest of the drains is less than 0.5 BCM/year for each.

Table 19 : Effluent (m^3/day) Discharged to Drains in the Delta

Drain	Domestic Point Sources m^3/day	Industrial Point Sources m^3/day	Domestic Diffuse Sources m^3/day	Agricultural Diffuse Sources m^3/day	Total m^3/day
Bahr El-Baqar	184000.0	64268.0	122795.0	4521678.0	6548741.0
Bahr Hadous	80000.0	6135.0	207754.0	4836000.0	5129889.0
Faraskour	2490.0	0.0	13272.0	186758.0	202520.0
El-Serw El-Asfal	7710.0	0.0	18769.0	508515.0	534994.0
El-Gharbia Main	156500.0	44460.0	293315.0	3927556.0	4421831.0
Tala	179.0	300.0	45076.0	1087148.0	1134318.0
Sabal	79000.0	0.0	39925.0	1196384.0	1315309.0
No. 8	0.0	0.0	42428.0	469848.0	512276.0
Bahr Nashart	22000.0	13968.0	108915.0	968859.0	1113742.0
No. 7	12500.0	0.0	39778.0	390056.0	442334.0
No. 1	39350.0	20960.0	78329.0	1204654.0	1343293.0
No. 9	0.0	0.0	88029.0	595644.0	683673.0
Zaghloul	0.0	0.0	1838.0	122890.0	124728.0
Edko	20000.0	7470.0	57346.0	4232034.0	4316850.0
Borg Rashid	0.0	0.0	0.0	311246.0	311246.0
El-Umoum	25000.0	0.0	81890.0	5163208.9	5270098.9
Abu-Keer	0.0	22897.0	15803.0	621592.2	660292.2
El-Batts	22396.0	0.0	26213.0	1468340.8	1516949.8
El-Wadi	3000.0	0.0	13272.0	1600340.6	1616612.6
Total (m^3/day)	2311740.0	180458.0	1294747.0	33412752.5	37199697.5
Total Billion m^3/year	0.84	0.066	0.47	12.2	13.6
% Ratio	6.2%	0.5%	3.5%	89.7%	

In terms of organic loads (BOD and COD), Bahr El-Baqar drain receives the highest load followed by Abu-keer drain. Also, El-Gharbia Main receives significant amounts of organic pollutants.

For the high loads of organic wastes received by Delta drains from domestic (point and diffuse) and industrial sources which represent sources of pollution for both River Nile and groundwater , some details will be presented.

Table 20: Loads of Pollution Received by Bahr Al-Bakar Drain

Source	Q m^3/d	Load (kg/d)					
		BOD	COD	SS	TDS	O&G	Heavy metals
Domestic Point Sources	1840000	356450	630850	327000	1363400	28200	1530
Domestic Diffuse Sources	122795	55257	73677	61397	96008	-	-
Industrial Point Sources	55938	28755	71108	31616	44834	5638	34
Total	**2018733**	**440462**	**775635**	**420013**	**1505242**	**33838**	**1564**

Table 21 : Loads of Pollution Received by Bahr Hadous Drain from Different Sources

Source	Q m^3/d	Load (kg/d)			
		BOD	COD	SS	TDS
Domestic Point Sources	80000	1680	3680	1600	61360
Domestic Diffuse Sources	207754	77459	110211	81782	179722
Industrial Point Sources	6135	1768	2606	2965	61360
Total	**293889**	**80907**	**116497**	**86347**	**302442**

Table 22: Loads of Pollution Received by Faraskour Drain

Source	Q m^3/d	Load (kg/d)			
		BOD	COD	SS	TDS
Domestic Point Sources	2490	223	377	220	1657
Domestic Diffuse Sources	13272	6450	9356	4870	10484
Industrial Point Sources	NA	NA	NA	NA	NA
Total	**15762**	**6673**	**9733**	**5090**	**12141**

Table 23: Loads of Pollution Received by El-Serw El-Asfal Drain

Source	Q m^3/d	Load (kg/d)			
		BOD	COD	SS	TDS
Domestic Point Sources	7710	897	1402	666	5203
Domestic Diffuse Sources	18769	8113	11823	6751	15568
Industrial Point Sources	NA	NA	NA	NA	NA
Total	**26479**	**9010**	**13225**	**7417**	**20771**

El- Mouheet Drain

El- Mouheet drain (70.2 km length) in El-Giza Governorate is considered as the second most polluted drains (the first is Bahr El- Baqar) in the Eastern Delta. The impact of El-Mouheet drain is much serious than Bahr El-Baqar since it discharge in El-Rahawy drain which connected directly with the River Nile (Rosetta Branch), while Bahr El-Baqar empties into Lake Manzala.

The main drain starts at El-Badrasheen and ends at Mansouria. It receives water from six intermediates on the right side discharging its water in Gannabiete El Mouheet El Youmna drain. Gannabiete El Mouheet El Youmna has 11 intermediates coming from the right side and one from the left. It also receives drainage water fro Gannabiete El Mouheet drain El-Yousra, with its one intermediate on the left side. The whole system discharging into the Nile through Rahawy Pumping Station.

Two main wastewater treatment plants are located within the drainage basin of El-Mouheet drain namely Abu Rawash and Zenein plants with maximum effluents of 700,000 and 400,000 m^3 /day, respectively.

It is important to mention, that the study (DRI, 2000) from which some data is mentioned in this section did not include the ambient water quality of the drains. Therefore, it is not possible to assess the impact of discharge of wastewater effluents on the quality of the drains.

1.4. Analysis of IDR data on monitoring the drainage system

For the unavailability of the data from IDR, we mentioned here to the comments from the report "Design of an Integrated National Water Quality Monitoring Network in Egypt- Water Quality Monitoring Network Design, Technical Report No. 2, June 1996) on the IDR monitoring data that covered the period 1991 – 1993.
The DRI data-bank comprises 105 monitoring locations in the drainage system in the Delta. In these locations, electric conductivity, pH and major ions were measured monthly and values of salinity, DSAR and RSC calculated from the measured parameters. Simultaneously, the same water quality parameters, measured in 28 locations in the irrigation canals receiving drainage water for reuse, were stored in the IDR data-bank.
The verification of the data indicated, that for approximately 75 % of the locations in the drainage canals, the values of the major ions and the pH were not really measured in the laboratory, but apparently simulated from the electric conductivity data. The locations which have real measured data are:

From the Eastern Delta, Bahr El-Baqar Drain (7 locations); Bah Hadous Drain (3 locations); Drain along Ismailia Canal (2 locations).

From the Middle Delta, El-Gharbia Drain (1 location) and Nashart Drain (1 location).

From the Western Delta, Edko Drain (one location); Nubaria Drain (6 locations) and Rsashid Drain (1 location).

In the selected locations, pH values seemed to be fairly constant over the year, with standard deviations usually below 0.2.

TDS values may vary considerably, depending on the location of the station and the season. For locations in the southern part of the Delta, TDS values are around 500 – 700 mg/l, with standard deviation over a longer period of approx. 100 – 150 mg/l. For locations in the northern part of the Delta, TDS values were around 1000 – 3000 mg/l, with standard deviations over a longer period of approx. 200 – 1400 mg/l. In locations with yearly variations, this variation

showed almost without exception a very specific patter: Reasonably stable salinity with a short peak in January of each year.
SAR values basically followed the trend of the salinity values.
This short analysis indicated that the drainage water monitoring should take place at least two times a year, basically in February and August. The measurements in February were critical, as the peak in salinity was short and might be completely captured by a measurement on a fixed date in February. The measurement in August was far less critical. Another solution to solve such problems of monitoring timing might be to measure electric conductivity regularly during three months in the wimter period and correlate other parameters (especially major ions, etc.) to electric conductivity.
A spatial analysis of variation of drainage water quality along the drainage canals was not possible, due to lack of monitoring locations.
The SAR limit, below which water become unsuitable for irrigation, varies with the salinity of the water. The higher the salinity, the higher the SAR limit was.
It is clear that there was a strong correlation between TDS and SAR (r=0.97). This was explained by the mechanism of increasing salinity in the drains: When salinity increases during the winter period, this increase was mainly caused by additional Na Cl. The proportion between Na on the one hand and Mg and Ca on the other hand would change accordingly, resulting in a very significant correlation.
Under the hydrological conditions that govern in the Delta, problems with SAR were not expected to occur other than in very exceptional cases. This was a clear indication that measurements/ calculation of SAR could be safely left out of the monitoring program, and decision with respect to drainage water reuse could be solely based on electric conductivity measurements and the levels of pathogens and toxic substances in the respective drainage water.

As conclusion and recommendations:

- To achieve safe use of drainage water in irrigation, many practices can be combined. The appropriate combination depends upon strategies of water, soil and plant. Soil management should be done. A selection of crops or crops tolerant varieties and special planting should be taken into consideration.
- Using controlled soil drainage condition, water management and efficient use of N-Fertilizer are important for reuse drainage water in irrigation purposes.
- Boron reaching drains from industrial wastes discharge may be toxic to sensitive crops which have potential health risks to human as well as animals.
- Although many of trace elements are essential for plant growth, excessive quantities will cause undesirable accumulation in plant

tissues and growth reduction. Heavy metals can pose significant health hazards to humans and animals and affecting irrigated crops.

- Most of the available studies assumed that organic loads received by drains are from domestic and industrial sources while the effect of diffuse agricultural discharges from the irrigated fields has been neglected.

  It should also be noted that the use of animal manure, dredged sediments from drains and sludge as fertilizers is practiced in Egypt. Leaching of part of these bio-fertilizers, which contains high concentrations of pathogens, heavy metals, organic compounds and nutrients is a major source of pollution. This is confirmed by the low water quality of the drains in spite of the high dilution factor. Data about this source of pollution is scarce and should be studied.
- Sewage contamination for drains water is proved by high incidence of bacterial indicator of pollution (fecal coliform) due to lack of sewerage system or insufficient wastewater treatment. To protect public health, the effluent of wastewater treatment plants should be properly disinfected before discharging to the drainage network and reuse for irrigation. The alternative is to use in restriction to certain crops which do not reach any part of a plant used for human or animal consumption.
- Monitoring the canals has only recently been included in the monitoring programs.
- Generally, treatment of pollution sources before draining into water ways is not only important but vital process. Finding simple and low cost treatment is the role of scientific research or technology transfer process.

Water Quality Status of the Nile River
The Center for Environmental Monitoring and Occupational Health Studies (MoHP)

The National Network for Monitoring the Pollutants in River Nile and its Branches is consisting of:

A- The central laboratories in Embaba – Cairo which are responsible for:

- Training and supervise the governorates laboratories.
- Samples collection and analysis, monthly, from the River Nile from Greater Cairo Sector between El-Saaf and Helwan at the south to the beginning of the two branches (Damietta and Rosetta) at the north. In case of any accidental case in any governorate, the center responsible for samples collection from the site to be analyzed in the central laboratories.
- Conducting heavy metals analysis for the samples collected from Greater Cairo sector as well as from all the covered governorates (Except Alex.).

B- Laboratories for River Nile pollutants monitoring in 11 governorates including:

Aswan, Souhag, Asuot, El- Menia, Bani – Sweif, Greater Cairo, El – Gharbia, El- Dakahlya, Damiatta, Alexandria and Port- Said.

- The annual monitoring program begins in 1993.
- Souhag and Port – Said laboratories begin the monitoring activities since 1998.
- Fayoum laboratories are under preparation.
- Monitoring program carried out through 135 point along the River Nile and the two branches beside some main canals such as Mahmoudia, Ismailia, Ibrahimia and large canals that branched from the River Nile at the main barrage at El-Kanater which feed from Riaah El-Tawfiky and El Menofy such as Bahr Moues, El-Bagoya, El-Kased- Bahr Shebin, and some points on Bahr Yousef.

A- Chemical Analyses:

Water samples analyses are conducted for the following parameters:

1- Parameters for detecting water quality including:

pH,electric conductivity, dissolves salts, water hardness, chlorides, total alkalinity,sulphates,minerals such as: sodium,potassium, calcium and magnesium.

2- Measuring the indicators of pollution including:

Ammonia, nitrite, nitrate, phosphate, dissolved oxygen, chemical oxygen demand (COD), biological oxygen demand (BOD).

3- Chemical pollutants including heavy metals and pesticides.

4- Bacteriological pollution including: total bacterial counts and coliform bacteria in Greater Cairo sector (a training program is arranged for staff of governorates laboratories to include the bacteriological analyses in their laboratories

Monitoring Points at Governorates

1- Aswan Governorate

11 monitoring point located along the Nile River distributed as:
1.a. one point on the High Dam Lake
1.b. 10 point on the Nile River can be classified as appeared in the following table

water treatment plants intakes	locations for Pollution Monitoring	outfalls of pollution sources at the connected points with the Nile River
* The old water treatment plant	* El-Tawysa Canal (Ballana)	* El-Seil "Kema" Drain
* Abu El-Reish treatment plant	* El-Kasel Canal "Raoof"	* Sugar Factory Drain At Kom-Ombo
*Draw Treatment plant		
* El-Rodyasa water treatment plant		* Sugar Factory Drain at Edfu
* Eklit water treat- ment plant		

2. Souhag Governorate

15 monitoring point located along the Nile River distributed as follows:

Water treatment plants intakes	Outfalls of industrial pollution sources	Points for organic pollution detection
Souhag	Discharge point of waste from Oil & Soap Factory on Nile River	Upstream of El-Mozawla Drain
Nasser	Discharge point of waste from Pepsi-Cola Co., on Nile River	Dawn stream of El-Mozawla Drain
Neida	Discharge point of waste from the Sugar Factory at Gerga on e Nile River	Flower Garden
El-Maragha		Rowing Club
Shatoura		
Gerga		
El-Manshaa		
Tahta		

3. Asuot Governorate

Monitoring carried out through 16 points, 13 of them located on the Nile River and 3 on Ibrahimia Canal.

The 13 points on the Nile River are distributed as follows:

Water treatment Plants intakes	Outfall for Pollution Sources	Points for Pollution monitoring
Assuot	El-Badary Drain	Down stream of El-Badary Drain
El-Arbeien (Compact unit)	Abou-Teig Drain	Down stream of Abou-Teig Drain
Manzalet Abd Alla	The point of discharge-ing the waste from the Fertilizers Co. at Mankabad with the Nile River.	Upstream of Abou-Teig Drain
	Manfalout Drain	Down stream of the Fertilizers Co, drain
		Down stream of Manfalout Drain.
		Upstream of Manf-alout Drain.

The monitoring points on Ibrahimia Canal are distributed as follows:

Outfalls for pollution Sources	Pollution Monitoring Points
Bani Korra oil Drain	Upstream of Bani Korra oil drain
	Downstream of Bani-Korra oil drain

4. El-Menia Governorate

Monitoring is carried out through 13 points, 6 of them located on the Nile River and 7 located on Ibrahimia Canal.
The points that located on the Nile River are distributed as follows:

Water Treatment Plants Intakes	Pollution Monitoring Points
New Mallwy	Down stream of Makousa Drain
El-Menia	Down stream of El-Mouheet Drain
	Upstream of El-Mouheet Drain

The points on Ibrahimia Canal are distributed as follows:

Water Treatment Plants Intakes	Outfalls of Pollution Sources
Deir-Mowas	El Sheikh Zaied Drain
Old Mallwy	
Samallout	
Ban-Mazar	
Maghagh	
Matay	

5. Bani-Sweif Governorate
Monitoring is carried out through 8 points, four of them are located on the Nile River and distributed as follows:

Water Treatment Plants Intakes	Outfalls of Pollution Sources
New BaniSweif	Ahnasia Drain
Old Bani-Sweif	El-Saidaa Drain

Two points are located on Ibrahimia Canal and representing the intakes of two water treatment plants namely Beba and Nasser.

Other two monitoring points are located on Bahr Yousif and representing the intakes of two water treatment plants namely Semista (compact unit) and El –Gizawia (compact unit).

6. Greater Cairo

Monitoring carried out through 18 points distributed as follows:

Water Treatment Plants Intakes	River Nile Branches	Pollution Monitoring Points
El-Ameriia (Ismailia Canal)	Beginning of Rosetta Branch	Moustrod (Ismailia Canal)
The Barrage (Nile River)	Beginning of Damietta Branch	Osman Bridge (Ismailia Canal)
Imbaba (Nile River)		El-Delta Co. for Iron and Steel (Ismailia Canal)
El-Giza (Nile River)		El-Galatma Bridge (Nile River)
El-Rouda (Nile River)		Starch & Glucose Co. (Nile River)
El-Maadi (Nile River)		El-Tibeen 1 (Nile River)
El-Badrasheen (Nile River)		El-Tibeen 2 (Nile River)
Gizerit El-Dahab (Nile River)		El-Hawamdia (Nile River)

7. El-Gharbia Gpvernorate

Monitoring points are 24, 17 of them located on large canals (e.g., Bahr Mous, and Shebien, El-Bagourya and El-Kased Canals) branched from the Nile River and fed from Rayah El-Monoufy & El-Tawfiky.
The 17 points are classified in two categories as appeared in the following table:

Water Treatment Plants Intakes	Pollution Monitoring points
Old Tanta	El-Kased Canal (Defra)
New Tanta	Kafr-Higazy (Residence area)
El-Mahalla El-Kobra (New)	Down Stream at Meet El-Moukhlis Bridge.
El-Mahalla El-Kobra (Old)	Upstream at Meet El-Moukhlis Bridge.
Kafr Hassan (Samanoud)	El-Santaa (Residence area).
El-Rahbein (Samanoud)	Hylana Canal (10th of Ramadan).
El-Kaddabah	Hylana Canal (El-Wady Co, for Cotton).
Beltag (Kotour)	Basyoon (Residence atrea)
	Kotour (Residence area)

Other 5 monitoring points are located on Rosetta Branch of the Nile River and distributed as follows:

Water Treatment Plants Intakes	Outfalls Pollution Sources	Monitoring Points for Pollution
El-Dalgamoon	Industries Collective Center at Kafr El-Zayaat	Down Stream of the Industries Collective Center.
	El-Kahera Co. for Petrol	Upstream of the Industries Collective Center.

The last 2 monitoring points are located on Damietta Branch of the Nile River. The first is located at the intake of Kafr El-Ghorieb “Zifta” water treatment plant and the second point is located at the residence area of Zifta City which represent a monitoring point for pollution.

8. El-Dakhleya Governorate

There are 8 monitoring points located on Damietta Branch of the Nile River, 3 of them representing the intakes of compact units for water treatment (Meet-Ghamr, Meet Ishna, Nowsa El-Bahr), and 5 representing the intakes for large water treatment plasnts (El-Mansoura, Meet Khamis, Talkha, Sherbein, and Bosat Karim El-Din).

9. Damietta Governorate

There are 7 monitoring points located on Damietta Branch of the Nile River and distributed as follows:

Water Treatment Plants Intakes	**Outfalls Pollution Sources**	**Monitoring Points for Pollution**
Kafr El-Shennawy	El-Serw El-Aala Drain	Upstream of El-Serw Drain
Faraskour		Down Stream of El-Serw Drain
El-Boustan		
Damietta		

10. Alexandria Governorate

There are 7 monitoring points located on El-Mahmoudia Canal, distributed as appeared in the following table.

Water Treatment Plants Intakes	**Monitoring points for Pollution**
El-Suof	Upstream of the beginning of drinking water canal.
El-Mansheya New	Upstream of El-Suof water treatment plant
	The end of El-Mahmoudia Canal in front of El-Nouzha bridge.
	The end of drinking water Canal..

11. Port-Said Governorate

There are 5 points located on Ismailia Canal representing the intakes for the following water treatment intakes;
El-Raswa – El-Kab – El Sedk – El Islah and Bahr El Baqar

The following table indicates the number of monitoring points in the Egyptian Governorates and location of these points:

No of Monitoring Points and its Location in Governorates
(Center of Environmental Monitoring and Occupational Health Studies – Ministry of Health and Population MoHP)

Governorates	No of points	River Nile	Rositta Branch	Damiatta Branch	Is mailia Canal	Mahmoudia Canal	Bahr Yousif	Ibrahimia Canal	High Dam Lake
Aswan	11	10	-	-	-	-	-	-	1
Souhag	15	15	-	-	-	-	-	-	-
Asuot	16	13	-	-	-	-	-	3	-
El-Menia	13	6	-	-	-	-	-	7	-
Bani-Sweif	8	4	-	-	-	-	2	2	-
Cairo	18	12	1	1	4	-	-	-	-
El-Gharbia	24	17	5	2	-	-	-	-	-
El-Dakahlya	8	-	-	8	-	-	-	-	-
Damietta	7	-	-	7	-	-	-	-	-
Alexandria	6	-	-	-	-	6	-	-	-
Port – Saied	9	-	-	-	4	-	-	-	-

Staff Members of the Central laboratory of the Center for Environmental Monitoring and Occupational Health Studies (MoHP):
Manager : B.Sc Phamacy
18 Chemist: 15 B.Sc Science, 3 B.Sc Agricultural Sciences (5 of them have Diploma after the B.Sc, 2 M.Sc Students, and one have M.Sc degree).
5 Technicians
4 Assistance Services

Laboratory facilities:
1-Ion chromatograph (anions, cations, heavy metals)
2-Nanodours (BOD, COD, Surfactants, TOC, and Amonia)
3-Atomic Absorbtion 2002 (Measuring 16 elements)
4- Instrument for mercury measurement
5- Gas Chromatography
6- GC- Mass Spectra 2004
7- HPLC for Pesticides and Biotoxin measurement
8- pH meter
9- Ec meter
10- Turbidity meter

11- Ovens
12- Incubators, Autoclave, Water Bathes, Membranes Filter.

Monitoring Data for year 2003

Since the construction of the Aswan High Dam, the water quality of the Nile in Egypt has become primarily dependent on the water quality and ecosystem characteristics of the reservoir (Lake Nasser), and less dependent on water quality fluctuations of the upper reaches of the Nile. Water released from Lake Nasser generally exhibits the same seasonal variation and the same overall characteristics from one year to another.

Downstream changes in river water quality are primarily due to a combination of land and water use as well as water management interventions such as: (a) different hydrodynamic regimes regulated by the Nile Barrages., (b) agricultural return flows, and (c) domestic and industrial waste discharges including oil and wastes from river boats. These changes are more pronounced as the river flows through the densely populated urban and industrial areas of Cairo and Delta regions.

The results of the 2003 monitoring campaign carried out by Ministry of Health and Population are presented in tables 24 – 31. Shading values in the tables denotes non-compliance with standards according to Law 48/1982. From the available data, mean values for monthly samples are calculated and the following can be concluded:

1- High Dam Aswan Lake (Lake Nasser)

The monitoring data showed that all figures all within the acceptable values according to Law 48/1982 (Tables 24 and 27).

2- Main River Stream (from Aswan to Cairo)

All the examined parameters along the River Nile (from Aswan to Cairo) showed values complying with the permissible limits by the Law 48/1984. Some exceptions appeared downstream of Aswan, at Souhag COD value exceeded the standard value reaching 11.7 mg/l. At Asuot, and Bani-Sweif, Nitrite concentration exceeded the standard, while total alkalinity and fluoride concentrations at Bani-Sweif and El-Menia Governorates, respectively, are not complying with the standards. Oil & Grease appeared at Asuot and El-Menia with un-acceptable concentrations (Table 24)

Table 24 : Water Quality of the Main Stream of Nile River from Aswan to Cairo (MoHP, 2003)

Parameters mg/l	Main Stream of the River Nile at:						
	High Dam Lake	Aswan Gov.	Souhag Gov.	Asuot Gov.	El-Menia Gov.	Bani-Sweif Gov.	Grater Cairo
Temperature ◦C	26.0000	26.0000	22.880	24.5900	21.1100	24.0000	23.8100
DO	6.22500	5.77900	8.0000	8.07600	7.51800	5.83500	6.45200
H_2S	0.00000	0.00000	0.1000	0.00000	0.04300	0.22300	0.00000
pH	7.79100	7.80000	7.1480	7.62700	7.83300	8.02300	7.46600
EC	255.333	262.908	279.86	279.570	246.919	616.727	374.228
NH_3- N	0.00000	0.00000	0.0000	0.26900	0.00040	0.01580	0.01920
NO_2	0.00000	0.00000	0.0000	0.05100	0.00120	0.56250	0.00060
NO_3	0.00000	0.00000	0.0000	0.00000	0.00110	0.00000	0.00000
Chlorides	16.4160	17.0690	10.870	17.2270	13.5140	35.5800	23.1020
Total Hardness	107.416	107.519	109.33	146.654	120.925	158.915	136.253
Ca Hardness	67.0830	67.0460	62.600	83.6500	71.4720	77.6210	77.2670
Mg Hardness	40.3330	40.3320	46.680	63.5360	45.2630	80.8100	58.4080
Ca	26.8330	26.8180	25.030	33.4620	29.6600	30.9300	30.5270
Mg	9.68000	9.71300	11.210	15.0860	10.0730	18.9040	14.1560
Total Alkalinity	118.999	121.640	127.33	126.070	117.632	166.155	144.914
Iron	0.00000	0.00000	0.0060	0.18500	0.00000	0.43500	0.03680
Mn	0.00000	0.00000	0.0000	0.11200	0.00000	0.00000	0.00000
Sulphate	13.6660	13.9450	ND	26.5130	21.3740	ND	28.5210
Phosphate	0.00800	0.00740	0.0201	0.53100	0.04000	0.13900	0.00060
Silicate	7.91600	9.13000	10.180	13.0090	0.42700	ND	5.03900
BOD	4.39100	5.31300	2.8500	2.37500	5.22900	1.90200	4.09200
COD	7.80800	9.49300	11.720	7.54300	8.26100	9.03500	9.86300
TDS	164.333	166.166	187.00	199.583	169.527	258.718	235.173
SS	17.0000	27.2520	ND	29.9070	13.5920	48.8520	18.1230
Fluorides	0.39100	0.39400	ND	1.96900	0.67600	0.40100	0.36300
Oil & Grease	0.00000	0.00000	ND	0.55600	0.63000	0.00000	0.00000
K	ND	ND	ND	5.33900	ND	ND	3.01200
Na	ND	ND	ND	20.0050	ND	ND	11.3680
Phenols	ND	ND	ND	ND	ND	ND	0.00000
Cyanide	ND	ND	ND	ND	ND	ND	0.00000

ND: Not Determined

Heave metals concentrations in the main stream of the River Nile are complying with the standards with three exceptions. Cadmium and Mercury showed high values than the standards at Asuot; El-Menia; and Bani-Sweif Governorates. In addition, Lead concentration at Bani-Sweif is exceeding the recommended level according to the Law (Table 25).

Table 25: Heavy Metals (mg/l) at Locations on the Main Stream of the Nile River from Aswan to Cairo (MOHP 2003)

Metals mg/l	Metal concn. in the River Nile main stream at:						
	High Dam Lake	At Aswan Gov.	At – Souhag Gov.	At Asuot Gov.	At El-Menia Gov.	At Bani-sweif Gov.	At Greater Cairo
Silver (Ag)	0.01350	0.02120	0.01140	0.06387	0.01208	0.03068	0.01066
Arsenic (As)	0.01550	0.02125	0.02586	0.01170	0.01489	0.02533	0.01239
Aluminium (Al)	0.02050	0.05985	0.04706	0.02070	0.05300	0.04816	0.01925
Cadmium (Cd)	0.00685	0.00634	0.00230	0.01497	0.01075	0.01068	0.00410
Chromium (Cr)	0.02250	0.01570	0.00236	0.23740	0.01225	0.03271	0.01050
Copper (Cu)	0.02950	0.03655	0.05966	0.05166	0.05152	0.06450	0.02256
Mercury (Hg)	0.00026	0.00041	0.00010	0.00212	0.00112	0.00165	0.00041
Nickel (Ni)	0.04850	0.03210	0.03060	0.03325	0.04245	0.03183	0.01166
Lead (Pb)	0.04500	0.02410	0.02456	0.03746	0.03147	0.05166	0.01525
Selenium (Se)	0.00475	0.00405	0.00438	0.00758	0.00682	0.00833	0.00585
Tin (Sn)	0.01500	0.01690	0.03286	0.02895	0.02825	0.02166	0.01141
Zinc (Zn)	0.09850	0.09655	0.09333	0.11334	0.06331	0.11600	0.06775

Assessment of Water Quality of River Nile

The Center of Environmental Monitoring and Occupational Health (MoHP)

Bacteriologically, the main stream of the River Nile showed high level of fecal contamination as appeared from fecal coliform density (!0^2 – 10^5 MPN/ 100 ml with 10^4 mean value). Algae appeared with density of 10^3/ml (Table 26).

2. Water Quality at the two Branches (Damietta and Rosetta)

Generally, Damietta Branch showed less pollution than Rosetta Branch.

Comparison between the Medium Values for some Parameters at the Monitoring Points on Rosetta and Damietta Branches

Parameters mg / l	Damietta Branch mg/l	Rosetta Branch
DO	6.29	5.52
BOD	3.90	30.87
COD	16.90	45.00

From the data in table 27, Rosetta Branch at the beginning (Cairo) showed values complying with the standards. At El-Gharbia, nitrie; total alkalinity; BOD; COD; and oil & grease are exceeded the standard values (Table 27).
On contrast, Damietta Branch, at the beginning (Cairo), showed higher COD value than Rosetta Branch which is an indication of chemical pollution with non-biodegradable materials. Along Damietta Branch and at the three governorates, nitrite concentrations exceeded the value recommended by the law. COD and oil & grease exceeded the standard values at El-Gharbia and Damietta Governorates. Although, the BOD value at the beginning of Damietta Branch is low (3.8 mg/l), it increased at El-Gharbia Governorate to reach value higher than the 6 mg/l as recommended by the law (Table 27).

Both the two branches showed values for heavy metal concentrations lower than the standards with two exceptions. The first, is cadmium in Damietta Branch and at El-Gharbia Governorate, while the second is Mercury in Rosetta Branch at El-Gharbia and El-Dakhleya Governorates (Table 28).

Bacteriological water quality showed similarity in density of fecal pollution for the beginning of both Damietta and Rosetta Branches (Table 26).
Algal counts showed also the same trend of similarity between the two branches (Table 26). Generally, biologically no difference between the main stream and the two branches (at the beginning).

Generally, the main stream at Cairo as well as the two branches (at the beginning) showed some slight contamination with pesticides (Table 29). The beginnings of both branches are less contaminated than the main river stream at Cairo (Table 28).

3. The Main Canals and Bahrs

The beginning of **Ismailia Canal** at Cairo showed values for chemical parameters complying with the standards (Table30). At Port-Said Governorates, nitrite; total alkalinity; COD and oil & grease exceeded the permissible limits according to the law.
Heavy metal values are complying with the standards at the beginning of the canal and at Port Said (Table 31).
Some slight pesticide pollution appeared in Ismailia canal (Table 29).

El-Mahmoudia Canal at Alexandria, have the same problems of pollution as Ismailia Canal (nitrite; total alkalinity; and oil & grease) (Table 30).
Ibrahimia Canal at Asuot is polluted by nitrite and oil & grease. At El-Menia only oil & grease exceeded the recommended values, while it showed complete complying with the standards at Bani-Sweif (Table 30). At Asuot Governorate, cadmium and chromium concentrations are higher than the standards. At El-Menia Governorate, there is some mercury contamination, while the canal water quality at Bani Sweif seemed complying with the standards (Table 31).

Bahr Yousif at Bani-Sweif showed only high value for total alkalinity while the othe parameters are complying with the standards (Table 30 and 31).
Canals at El-Gharbias Governorate (**El-Bagourya, El-Kassed) and Bahr Mous and Shebein)** are contaminated with nitrite; oil & grease as well as organic and chemical pollutants as appeared from high BOD and COD values (Table 30). Heave metal concentrations are complying with the standard (Table 31).

Table 26 : Microbiological Water Quatity of River Nile, its Two Branches and Ismailia Canal (MoHP, 2003)

Biological Parameters	Density of the tested parameters at:			
	The main stream of the Nile River	Beginning of Damietta Branch at Cairo	Beginning of Rosetta Branch at Cairo	Ismailia Canal at Cairo
Total coliforms MPN/100ml	(1.6×10^3 – 6.0×10^5) * 6.2×10^4	(3.8×10^3 – 1.9×10^5) * 5.4×10^4	(2.2×10^3 – 1.9×10^5) * 5.3×10^4	(2.0×10^3 – 7.4×10^4) * 1.3×10^4
Fecal coliforms MPN/100ml	(3.6×10^2 – 5.3×10^5) * 3.4×10^4	(5.6×10^2 – 5.4×10^4) * 1.5×10^4	(6.0×10^2 – 5.4×10^4) * 1.4×10^4	(5.6×10^2 – 1.1×10^4) * 3.9×10^3
Total algal counts unit/ml	(1.5×10^3 – 4.6×10^3) * 2.5×10^3	(2.2×10^3 – 3.0×10^3) * 2.6×10^3	(1.5×10^3 – 3.6×10^3) * 2.5×10^3	(1.6×10^3 – 4.3×10^3) * 2.8×10^3

( ):Ramge values * Mean values

Table 27 . Water Quality of the to Branches of the Nile River (MoHP, 2003)

Parameters	Bosetta Branch		Damietta Branch			
	Beginning Rosetta Branch at Cairo	Rosetta Branch at El-Gharbia Gov.	Beginning at Cairo	At El-Gharbia Gov.	At El-Dakhleya Gov.	At Damietta Gov.
Temperature ◦C	23.9100	24.3700	23.9100	24.1100	23.5600	23.7600
DO	6.60000	5.46800	6.70800	6.21600	6.00000	6.00000
H_2S	0.00000	ND	0.00000	ND	ND	ND
pH	7.51600	8.01500	7.57000	8.23500	7.49000	7.86700
EC	362.500	529.816	367.166	389.333	416.288	445.055
NH_3- N	0.02850	0.30270	0.02100	0.04150	0.14500	0.27600
NO_2	0.00050	0.34480	0.00070	0.02470	0.01660	0.08790
NO_3	0.00000	0.14140	0.00000	0.05970	0.15640	0.43570
Chlorides	22.4920	43.5500	22.3330	25.8330	34.0120	50.5970
Total Hardness	136.250	223.316	135.249	183.833	143.460	160.090
Ca Hardness	76.7500	127.033	77.6660	106.833	80.6100	87.1800
Mg Hardness	59.5000	95.8330	57.5830	78.1660	62.8400	75.9700
Ca	30.7000	50.4960	31.0160	43.1500	32.2400	34.8400
Mg	14.2800	23.0000	13.8200	16.3850	15.0900	17.4900
Total Alkalinity	143.833	155.766	143.166	135.291	168.150	167.640
Iron	0.08750	0.03930	0.05200	0.02710	0.01820	0.03140
Mn	0.00000	0.01170	0.00000	0.00000	0.00000	0.00000
Sulphate	27.0410	35.0800	27.6660	22.2390	ND	46.3400
Phosphate	0.00200	0.04500	0.00020	0.01280	0.18330	0.70320
Silicate	5.04100	2.00800	4.88300	1.67700	3.51960	4.13180
BOD	4.02500	33.2350	3.87500	6.49900	2.50000	ND
COD	9.82100	48.2000	10.2340	10.8160	8.40000	22.8000
TDS	238.166	371.316	230.583	275.458	274.000	332.000
SS	18.1660	39.4330	16.6660	12.0000	19.2050	ND
Fluorides	0.38700	0.31100	0.36600	0.24060	0.34160	ND
Oil & Grease	0.00000	27.9660	0.00000	13.6660	0.00000	2.38800
K	3.00000	ND	2.91600	ND	ND	ND
Na	11.7080	ND	11.8000	ND	ND	ND
Phenols	0.00000	ND	0.00000	ND	ND	ND
Cyanide	0.00000	ND	0.00000	ND	ND	ND

ND: Not Determined

Table 28 : Heavy Metals (mg/l) in the Two Branches of the Nile River (MOHP 2003)

Metals	Heavy metals concentration at:					
	Damietta Branch			Rosetta Branch		
	Beginning at Cairo	At El-Gharbia Gov.	At Damietta Gov.	Beginning at Cairo	At El-Gharbia Gov.	At Dakhleya Gov.
Silver (Ag)	0.00666	0.00850	0.02626	0.00900	0.01740	0.00666
Arsenic (As)	0.02050	0.01950	0.01857	0.00975	0.01460	0.02318
Aluminium (Al)	0.01300	0.07450	0.04989	0.01700	0.03720	0.03730
Cadmium (Cd)	0.00500	0.09200	0.00480	0.00325	0.00162	0.00106
Chromium (Cr)	0.00833	0.00320	0.02142	0.01266	0.01100	0.00359
Copper (Cu)	0.02325	0.01240	0.02463	0.03000	0.07580	0.01361
Mercury (Hg)	0.00033	0.00055	0.00047	0.00046	0.00198	0.00133
Nickel (Ni)	0.01033	0.02600	0.02526	0.01333	0.02340	0.04380
Lead (Pb)	0.00875	0.02650	0.02552	0.01225	0.02080	0.02110
Selenium (Se)	0.00415	0.00785	0.00800	0.00550	0.00670	0.00604
Tin (Sn)	0.00933	0.02750	0.00552	0.00600	0.01880	0.01580
Zinc (Zn)	0.05625	0.05400	0.07026	0.06575	0.07200	0.10740

Pesticides	Ranges of Pesticide Concentration (mg/l) at :			
	Main River Stream at Cairo	Beginning of Damietta Branch at Cairo	Beginning of Rosetta Branch at Cairo	Beginning of Ismailia Canal at Cairo
Somthrin	0.04-0.3	0.21-2.0	ND	ND
Malathion	0.1-2.0	1.0	1.0	0.21-3.6
Dorsban	0.04-0.062	ND	ND	0.004-0.22
Fenitrothian	0.16-0.5	0.16-0.45	0.09-0.52	0.02-0.32
Ethion	0.43	1.0	ND	ND
Parathion	0.1-0.36	ND	ND	0.1-0.6
Dimethoat	0.04-0.86	ND	ND	ND
Pyrofezine	0.02-0.08	ND	ND	0.002-0.006
Chlor pyrihos-methyl	0.016-0.27	0.015	0.044	0.018
E.S Fenvalerate	2.248	ND	ND	ND
Hexa chloro Hexane HCH:				
Alpha	0.94	ND	ND	0.9-1.0
Beta	0.17	ND	ND	0.6
Delta	0.01-0.1	0.1	1.0	0.04-0.1
Gama	0.003-0.1	ND	0.007	0.30
Hepta chlore	0.14-2.0	ND	0.008	0.1-0.2
Hepta chlorepoyide	ND	ND	ND	0.16
DDT:				
O,P	0.004-0.806	1.01	0.2	0.94-9.4
P,P	0.078-1.3	0.2	0.3-0.53	0.12-0.4
D.D.D:				
O,P	0.62	ND	ND	ND
P,P	0.096-0.5	0.2-0.352	ND	0.03-0.26
D.D.E:				
O,P	0.1-0.5	ND	ND	0.1-0.7
P,P	0.03-0.4	ND	ND	ND
Aldrin	**0.006-0.3**	**0.09**	**0.3**	**ND**
Deldrin	**ND**	**ND**	**ND**	**0.13**
Andrin	**0.027-0.1**	**ND**	**ND**	**ND**

Table 29: Pesticides Detected in the Main Stream of the Nile River, its Two Branches and Ismailia Canal (MoHP, 2003)

ND: Not Detected

Table 30 : Water Quality of the Main Canals and Bahrs

Parameters mg/l	Ismailia Canal		El-Mahmoudia Canal	Ibrahimia Canal			Bahr Yousif	Bahr Mous, El-Bagourya Canal, El-Kasel Canal, and Bahr Shebein
	Beginning at Cairo	At Port-said Gov.	At Alexandria Gov.	Ibrahimia Canal at Asuot	Ibrahimia Canal at El-Menia	Ibrahimia Canal at Bani-Sweif	Bahr Yousif at Bani-Sweif	
Temperature ◦C	23.9700	24.4100	ND	25.0000	20.5800	24.5000	25.2500	24.2100
DO	6.56400	6.61000	5.10000	7.74400	7.48100	6.10000	5.82900	6.92100
H_2S	0.00000	0.68900	0.15600	0.00000	0.03600	0.23100	0.27000	ND
pH	7.49700	8.31000	7.56300	7.84100	7.81800	7.98700	7.90000	8.26900
EC	372.541	431.416	432.810	263.527	247.722	414.125	708.520	416.435
NH_3- N	0.02450	0.30000	0.25600	0.31800	0.00100	0.00580	0.00630	0.05850
NO_2	0.00081	0.09500	0.66150	0.07800	0.00000	0.00000	0.00000	0.08860
NO_3	0.00000	0.00000	0.01250	0.10500	0.00080	0.00000	0.00000	0.05320
Chlorides	22.6250	31.3700	47.9300	18.7220	12.6250	19.1620	45.0370	27.5280
Total Hardness	134.374	136.720	189.110	148.888	113.694	115.750	172.500	183.439
Ca Hardness	75.7330	86.5920	104.972	81.6110	73.0270	64.1250	80.7910	104.812
Mg Hardness	58.7080	34.7300	84.1300	67.2770	44.9160	52.7500	91.7080	83.5490
Ca	30.2830	49.6600	45.1800	32.6270	27.9740	25.6620	32.3160	45.4500
Mg	14.0900	11.9200	20.1600	16.0130	10.8460	12.2210	22.1700	20.4900
Total Alkalinity	143.937	161.270	158.720	134.000	109.347	131.000	150.250	141.309
Iron	0.02930	0.19480	0.17300	0.04800	0.01380	0.25620	0.49060	0.02540
Mn	0.00000	0.00000	0.00000	0.03400	0.00000	0.00000	0.00000	0.00000
Sulphate	28.1970	34.8400	56.2600	21.0830	21.8050	ND	ND	23.7700
Phosphate	0.00075	0.43100	5.72780	0.16600	0.02900	0.12560	0.14470	0.01340
Silicate	0.72900	22.7400	4.95820	12.7940	0.44100	ND	ND	1.56600
BOD	3.70200	2.62000	2.57000	2.91600	4.77000	1.43100	1.56210	10.9750
COD	9.31500	13.9700	16.8000	7.78800	7.73800	6.47000	9.05800	15.5950
TDS	234.791	264.000	359.000	179.722	158.472	196.071	259.428	294.617
SS	20.5620	27.3600	69.0410	29.8330	13.8330	50.2850	68.2140	16.1440
Fluorides	0.35510	0.31230	0.48750	0.30000	0.15500	0.34700	0.44400	0.25990
Oil & Grease	0.00000	12.8330	0.00000	0.64900	0.40900	0.00000	0.00000	14.8180
K	2.98700	ND	ND	5.10000	ND	ND	ND	ND
Na	11.8120	ND	ND	22.9710	ND	ND	ND	ND
Phenols	0.00000	ND	ND	ND	ND	ND	ND	ND
Cyanide	0.00000	ND	ND	ND	ND	ND	ND	ND

Table 31: Heavy Metals (mg/l) at the Main Canals and Bahrs (MOHP 2003)

Metal	Ismailia Canal		Ibrahimia Canal			Bahr Yousif	Bahr Mous,El-Bagourya Canal,El-Kasel Canal, and Bahr Shebein
	At Greater Cairo	At Port-Said Gov.	At Asuot Gov.	At El-Menia Gov.	At Bani-Sweif Gov.	At Bani-Sweif Gov.	
Silver (Ag)	0.00816	0.00655	0.04150	0.02542	0.01500	0.02200	0.01205
Arsenic (As)	0.01012	0.01369	0.01647	0.01480	0.01450	0.01333	0.01308
Aluminium (Al)	0.02358	0.04900	0.03016	0.06335	0.01533	0.01466	0.04941
Cadmium (Cd)	0.00537	0.00451	0.01180	0.00571	0.00365	0.00251	0.00319
Chromium (Cr)	0.01416	0.00888	0.05650	0.00978	0.01490	0.01060	0.00910
Copper (Cu)	0.03625	0.02523	0.04151	0.04238	0.02450	0.01750	0.05858
Mercury (Hg)	0.00072	0.00058	0.00541	0.00112	0.00055	0.00036	0.00067
Nickel (Ni)	0.02358	0.01211	0.03783	0.05264	0.01766	0.00600	0.02664
Lead (Pb)	0.01743	0.01415	0.04358	0.02471	0.02166	0.01166	0.02576
Selenium (Se)	0.00531	0.00466	0.00721	0.00647	0.00733	0.00516	0.00713
Tin (Sn)	0.01508	0.04759	0.02191	0.03178	0.01333	0.01166	0.04470
Zinc (Zn)	0.05643	0.08546	0.10233	0.08171	0.06383	0.04416	0.06841

Conclusions

1- Some monitoring points showed increase in COD and BOD values which are indicators of chemical as well as organic pollution resulted from discharging of municipal and industrial wastes on water course of River Nile, the two branches and the main canals especially Ismailia and Mahmoudia.
2- River Nile still has the ability of self purification due to its length, high flow, and the monthly flooding which renews the water in the river, beside the environmental law enforcement.

Recommendations

1- More strict control on sources of pollution in order to prevent industrial wastes disposal (rejection) on surface water.
2- Ministry of Water Resources and Irrigation should limit the raise of drains water to surface fresh water and should look for alternatives in order to conserve water quality especially in canals that represent the source of drinking

water (Mahmoudia and Ismailia canals).

3- Ministry of housing should extend the sanitary services (sewerage system) to those not supplied with the services, and consider the treatment efficiency for the existed wastewater treatment plants, updates then and finding the simple technology of treatment for the rural areas. Applications of wastewater re-use should be expanding in order to limit waste discharge on the River Nile and canals.

4- Water treatment plants intakes should be protected and cared according to the Ministerial law No 301/ 1995.

5- Recommendations should be directed to the Local Administration Units in order to follow continuous monitoring program to protect the water courses.