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POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 34
Main Document

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International Resources Group Winrock International Nile Consultants

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Main Document

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Special thanks are given to the authors of the following six Appendices to this document:

Appendix 1 Wastewater Treatment in Egypt
By Eng. Magda Gaballa and Eng. Mamdouh Mohsen of NOPWASD
Appendix 2 Health Impact and Water Quality Standards in Wastewater Irrigation
By Dr. Sehem Hendi of MOHP
Appendix 3 Wastewater Irrigation for Forest Plantation
By Dr. Mamdouh Riad of MALR
Appendix 4 Industrial Wastewater Management
By Dr. Ahmed Gamal Eldin of EEAA
Appendix 5 Wastewater Effluents Administration and Management
By Eng. Yahia Abdel Aziz of MWRI
Appendix 6 Priorities for Improving Drainage Water Quality in the Delta
By Dr. Ahmed Fakhry Khattab of EPIQ and Dr. Hesham Kandil of MWRI

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1. Table of Contents

ACRONYMS AND ABBREVIATIONS

AGOSD	Alexandria General Organization for Sanitary Drainage
APRP	Agricultural Policy Reform Program
BCM	Billion Cubic Meters
BOD	Biological Oxygen Demand
CGOSD	Cairo General Organization for Sanitary Drainage
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EEAA	Egyptian Environmental Affairs Agency
GOE	Government of Egypt
M&I	Municipal and industrial
MALR	Ministry of Agriculture and Land Reclamation
MCM	Million Cubic Meters
MOHP	Ministry of Health and Population
MHUUC	Ministry of Housing, Utility, and Urban Communities
MWRI	Ministry of Water Resources and Irrigation
NOPWASD	National Organization for Potable Water and Sanitary Drainage
O&M	Operations and Maintenance
USAID	United States Agency for International Development
TDS	Total Dissolved Solid
WHO	World Health Organization
WPAU	Water Policy Advisory Unit
WWTP	Wastewater Treatment Plant

Executive Summary

Introduction

The purpose of this document and the six appendices is to present the results of the work carried out under Benchmark C2 of the Memorandum of Understanding between the Arab Republic of Egypt (GOE) and USAID/Egypt for the APRP Tranche IV (1 July 1999 – 31 December 2000).

The benchmark states:

> *The GOE (MWRI) will adopt policies for improved management of discharge and reuse of urban wastewater in agricultural drains.*

The verification indicator is:

> *The MWRI will approve a policy and procedures for managing and reusing urban wastewater discharges in agricultural drains and submit them to the Cabinet by 31 December 2000.*

Benchmark Activities

Accomplishing the benchmark requires the active involvement of several ministries and agencies. Participation, cooperation, and consistent policy development from all involved ministries were targeted from the very beginning of the benchmark design. A principle element in benchmark activity design is the contribution from each party's experience and wisdom for a commonly agreed policy. An APRP/MWRI Wastewater Task Group was organized with representatives from the following five ministries and agencies:

- Ministry of Water Resources and Irrigation (MWRI)
- Ministry of Agriculture and Land Reclamation (MALR)
- Ministry of Health and Population (MOHP)
- National Organization of Potable Water and Sanitary Drainage (NOPWASD) of the Ministry of Housing, Utilities, and Urban Communities (MHUUC)
- Egyptian Environmental Affairs Agency (EEAA)

Under the benchmark, the following major activities were conducted during the period from 1 July 1999 – 31 December 2000:

- Established a conceptual framework, including identification of critical areas of urban wastewater management, to guide policy development.
- Organized an APRP/MWRI Wastewater Task Group to carry out benchmark activities. The group, composed of eight representatives from the five cooperating ministries and agencies, routinely met every 2-3 weeks, and organized four workshops to discuss policies and monitor benchmark activities.

- Conducted, for the first time in Egypt, a sampling program for the water microbial features in Salaam Canal, its feeding drains, and the effluents of the Mansoura wastewater treatment plant.
- Participated in a MOHP-WHO sponsored wastewater irrigation training to promote public awareness.
- Conducted international study tours to Jordan (a neighboring country with an equivalent economic development level) and California, USA (renown for its stringent water quality standards and the most advanced wastewater treatment technology) to gain from their wastewater management experiences.
- Organized inter-ministry policy development by providing each party with policy outlines and technical discussions. Appendices 1-6 are the representatives' reports from each cooperating ministry or agency.

This Summary Policy Document report presents conclusions reached by, and recommended policies of, the APRP/MWRI Wastewater Task Group.

Recommended Policies and Procedures

The Delta region (including Greater Cairo) has an estimated population of 45 million and generates more than 2 billion cubic meters of wastewater per year. A majority portion of this large volume is from cities and towns. Agricultural drains receive all types of wastewater and experience more severe contamination than the Nile River and canals. However, agricultural drainage is part of the irrigation source in the Delta. The management of wastewater discharge and reuse should receive priority consideration in Egypt's water pollution control.

Wastewater enters the large-scale Nile irrigation system by two mixing processes: to mix with agricultural drainage in drains, and to mix with freshwater in canals. These two mixing processes disperse pollution and degrade the water quality of the entire irrigation system. A fundamental impetus for remedial policy development is to minimize the wastewater entrance at these two mixing processes.

Treatment is fundamental and ultimate to wastewater management. However, full treatment of wastewater in the Delta is far from reality, given the nation's economic development level. Even in those constructed treatment plants, operations are inefficient, and the environmental improvements from plant operations are not strongly evident.

The general Nile irrigation is an unrestricted irrigation. Canal water, after being mixed with drainage water, is used without crop restrictions. The unrestricted irrigation system is vulnerable from the intrusion of wastewater. Given the fact that an alternative to drains as sewage dumping sites is impossible in the Delta, a central need is to exhaust the wastewater in restricted uses so that its effect on the general Nile irrigation system can be minimized.

Restricted uses of wastewater are not well developed in Egypt. However, the wastewater irrigation on timber trees in the deserts conducted by the Afforestation Department of MALR has proven feasible and promising. A direct benefit is the reduction of unwanted wastewater in the general Nile irrigation system.

Law 48 is the governing law for water quality management in Egypt. Law 48 sets specific water quality standards in Articles 65 and 66 for the two mixing processes in addition to Articles 60-64 for general waste discharge in canals. Although Law 48 has no specifications on intestinal nematode eggs - the major threats to human health from wastewater, the pioneer legislators recognized the importance of the two mixing processes in Egyptian water quality management. The 1989 World Health Organization Guidelines and the newly issued Ministerial Decree 44/2000 (by the Ministry of Housing, Utility, and Urban Communities) distinguish the water quality requirements for unrestricted and restricted irrigation. However, compliance with these water quality standards remains to be implemented.

The management of urban wastewater involves many stakeholders including government ministries and the private sector. There are outstanding issues and questions concerning authority, responsibility and cooperation among these stakeholders.

The benchmark task group has recommended the following policies and procedures for improved urban wastewater management.

1) Treatment of Wastewater

Policy #1 ***In wastewater treatment plant construction, the territorial equity rationale must be replaced by a broader national interest. The criteria for prioritizing the construction of wastewater treatment plants should be:***

- ***To protect human health (mainly drinking water sources);***
- ***To sustain agricultural drainage reuse; and***
- ***To maintain ecological balance in lakes and on seashores.***

Procedures *NOPWASD, together with MWRI, MOHP, and EEAA, should prepare a prioritized construction and implementation plan for wastewater treatment plants for the period 2000-2007, based upon the above mentioned priority criteria, available budget, and current on-going construction activities.*

Policy #2 ***An urgent need in wastewater treatment is to improve the effectiveness of those treatment plants already constructed and operational.***

Procedures *NOPWASD should create more educational and practical opportunities for the development of Egyptian wastewater treatment professionals. WWTP operation codes, operator license system, and effluent quality control must be enforced. The corporation model of the Public Economic Authority, as a transition to full privatization of wastewater services, should be extended to more governorates, and a user-pays, self-reliant finance mechanism must be exercised in those authorities. NOPWASD should also strengthen public awareness education about urban wastewater services.*

Policy #3 ***Minimize the discharge of industrial wastewater to municipal sewers and agricultural drains. Agricultural drains are not open dumping sites for industrial wastes, and pre-treatment of industrial toxic wastes at the source is a must.***

Procedures *EEAA should extend its effort of restricting industrial waste dumping in the Nile River to the agricultural drains and city sanitary sewers. New industries, either large or small, must meet the at-source treatment requirements for permitted operation. MWRI, in cooperation with EEAA and MOHP, should establish more restrictions on industrial wastewater discharge in agricultural drains.*

2) Health Concerns and Wastewater Quality Standards

Policy #4 ***The primary threats of wastewater irrigation to human health are pathogenic organisms found in wastewater including bacteria, viruses, protozoa, and helminthes.***

Procedures *MOHP, in cooperation with MWRI and NOPWASD, should strengthen public awareness education on the human health risks of wastewater irrigation. All cooperating ministries should establish a better understanding of the various potential mitigating measures and their applications under the Egyptian conditions. MOHP should increase its scientific research to examine human health risks from wastewater irrigation in the Egypt. NOPWASD should pay more attention to the effective removal of pathogens in treatment plants.*

Policy #5 ***The water quality requirements issued in Law 48 and MHUUC Ministerial Decree No 44/2000 represent the authorized standards in Egypt. All involved ministries and agencies should better recognize the role of MOHP in wastewater quality inspection and regulatory development.***

Procedures *MOHP should accelerate technical capacity building at both national and local levels for the increasingly complicated quality monitoring and inspection tasks. MWRI should classify the Nile watercourses for different water quality standard applications. MOHP, in cooperation with MWRI and other involved ministries, should develop clear responsibility lines in monitoring wastewater treatment plants, mixing points in drains and canals, lakes and seashores, unrestricted and restricted irrigation fields, and other sites of particular interest.*

3) Discharge and Reuse of Wastewater

Policy #6 ***Separation of wastewater from agricultural drains is critical to sustain general irrigation in the Delta. Efforts in this direction, including drain function classification, intermediate drainage reuse, and wastewater tree-irrigation in the desert, should be recognized and supported.***

Procedures *MWRI, in cooperation with NOPWASD, MOHP, and local municipal authorities, should organize an overall drain classification program for the Delta. MWRI, in cooperation with local municipal authorities, should assess and implement, in steps, necessary penalties for discharging untreated wastewater into classified reuse drains and using drain water from classified discharge drains.*

Policy #7 ***The MWRI drainage-monitoring program has functioned as a main technical support in Delta region's water quality management during the past two decades. The program should be encouraged and continued.***

Procedures *MWRI, in cooperation with MOHP and EEAA, should upgrade the existing drainage monitoring program for more competent wastewater-related monitoring work.*

Policy #8 ***Follow the MHUUC Ministerial Decree 44/2000 and WHO 1989 Guidelines to initiate restricted irrigation for the safe use of wastewater on selected crops.***

Procedures *MALR, in cooperation with MWRI and MOHP, should plan crop zones for different quality irrigation sources in the Delta. MALR and MWRI should test pure wastewater irrigation for selected crops with cautious assessment of the possible groundwater contamination in neighboring areas.*

Policy #9 ***Wastewater effluent irrigation on timber trees in the desert is an environmentally and economically sound reuse. The effort should be recognized, encouraged, and supported.***

Procedures *MALR should expand its current effort to promote wastewater irrigation of timber trees in the desert by strengthening public awareness education programs and by providing stronger economic incentives to attract private sector participation. MALR and MWRI should better cooperate to conduct environmental impact assessment, particularly groundwater impact evaluation, for wastewater irrigation in timber tree plantation.*

Policy #10 ***Use wastewater effluents to grow green lands in cities and towns in the Delta.***

Procedures *The Afforestation Department of MALR, in cooperation with MWRI and Dakhalia Governorate, should conduct a pilot program using wastewater effluents to grow street trees in Mansoura City. The pilot work should include an environmental impact assessment.*

4) Inter-ministry Cooperation

Policy #11 ***Inter-ministry cooperation is the foundation of the urban wastewater management endeavor. MWRI, as the national water authority, has to take the lead in developing and sustaining the cooperation.***

Procedures *Establish a commonly agreed cooperation framework, clarify each party's authority and obligation lines, and establish a financial mechanism to support cooperation in water quality management.*

1. Introduction

1.1 Overview

The Agricultural Policy Reform Program (APRP) is a six-year United States Agency for International Development (USAID) grant program involving several ministries. The Ministry of Water Resources and Irrigation (MWRI) is the primary Egyptian governmental agency charged with the management of water resources. MWRI and USAID, under the umbrella of the APRP, jointly designed a water policy package, which consists of integrated water policy and institutional reforms. USAID supports the Ministry's efforts through annual cash transfers based on performance in achieving identified and agreed upon policy reform benchmarks and technical assistance.

Co-ordination among MWRI, USAID, and the water policy technical assistance program is through the Water Policy Advisory Unit (WPAU) and a project steering committee established by the MWRI. Technical assistance for the water policy analysis activity is provided through a water resources results package task order (Contract PCE-I-00-96-00002-00, Task Order 807) under the Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (APRP/MWRI) between USAID and a consortium headed by the International Resources Group (IRG) and Winrock International. Local technical assistance and administrative support is provided through a subcontract with Nile Consultants.

1.2 Purpose of the Report

A Memorandum of Understanding between the Arab Republic of Egypt and USAID, dated 20 September 1999, listed the mutually agreed policy reform benchmarks for the APRP Tranche IV period (1 July 1999 – 31 December 2000). Benchmark C2, Urban Wastewater Discharge and Reuse, states:

> ***The GOE (MWRI) will adopt policies for improved management of discharge and reuse of urban wastewater in agricultural drains.***

The implementation of this benchmark extends into two years. Satisfactory achievement of the benchmark requires the accomplishment of the following two verification indicators:

1) *The MWRI will approve a policy and procedures for managing and reusing urban wastewater discharges in agricultural drains and submit them to the Cabinet by 31 December 2000.*
2) *The MWRI in coordination with other ministries and authorities will apply the policy and procedures in one selected pilot area in the Delta by 31 December 2001.*

The purpose of this report, including its six appendices, is to address the first verification indicator by presenting the proposed policies and procedures for the management of urban wastewater discharge and reuse.

1.3 Background

With rapid population growth and industrialization over the past decades, the Nile River and its canals and drains, particularly the drains in the Delta, have become contaminated, as indicated by consistently high fecal coliform levels and the closed operation of several main drainage reuse pump stations. Serious policy actions to combat water pollution caused by wastewater discharge and prevent further degradation of the Delta's water environment are urgently needed.

The Delta region (including Greater Cairo) has an estimated population of 45 million and generates more than 2 billion cubic meters of wastewater per year. A majority portion of this large volume is from cities and towns. Among the identified main pollutants (pathogens, heavy metals, pesticides, and salinity) in the Delta's water environment, pathogens are the most harmful. Pathogens mainly originate in urban sewage and pose significant human health and agricultural production problems. Drains in the Delta receive all types of wastewater and experience more severe water contamination than the Nile River and canals. However, drain water is reused as part of the irrigation source in Egypt, a practice that will continue in the future. The management of sewage discharge, particularly the large volume and concentrated urban sewage discharge in Delta agricultural drains, should receive priority consideration in Egypt's water pollution control efforts.

The treatment of urban wastewater is practiced in Egypt. Nevertheless, there are gaps between the available treatment capacity and the demands for treatment; full treatment of urban wastewater will not be possible soon. There is also a problem of prioritizing the locations and treatment levels of urban wastewater so that they can better support the MWRI drainage reuse policy. Even for treated effluents, there is a question of how best to use them for improving environmental quality and supplying agricultural irrigation.

There are three major issues related to urban wastewater discharges:

- Pollution in the Nile system, particularly in agricultural drains in the Delta, poses increasing risks to human health and agricultural sustainability. Without action, the region's prosperity will deteriorate.
- Large volume and concentrated discharges of urban wastewater in agricultural drains increasingly threaten the sustainability of drainage reuse in the Delta.
- Pollution consumes large amount of usable drainage in the Delta.

Water quality is an essential component of Egypt's water management; however, it has not been adequately addressed. The APRP Tranche III Benchmark C8 (Law 48 Amendment) represented one of the efforts to address water quality issues within a policy and legislation framework. The benchmark recommended a compliance action plan for pollution abatement. One important component of that plan is the management of wastewater discharge in agricultural drains.

This benchmark, as a continuing effort of the Tranche III Benchmark C8, will establish integrated policies and procedures for managing urban sewage discharge. The objectives of the benchmark are to:

- Establish an integrated policy for handling urban sewage disposal and reuse;

- Enhance compliance with the objectives and targets of Law 48; and
- Promote coordination and implementation between MWRI and other ministries in water pollution control and environmental quality management.

Anticipated effects for this benchmark include:

- Integration of MWRI strategies for discharging and reusing urban wastewater;
- Enhancement of MWRI capabilities in managing urban sewage disposal; and
- Improvement of inter-ministry coordination in urban wastewater disposal and reuse.

1.4 Benchmark Activities

The benchmark has a two-stage implementation plan: Phase I (November 1999 – December 2000) to develop policies and accompanying procedures, and Phase II (December 2000 – December 2001) to test and modify the policies and procedures. Accomplishing the benchmark requires the active involvement of several ministries and agencies. Participation, cooperation, and consistent policy development from all involved ministries were targeted from the very beginning of the benchmark design. A principle element in benchmark activity design is the contribution from each party's experience and wisdom for a commonly agreed policy. An APRP/MWRI Wastewater Task Group was organized with representatives from the following five ministries and agencies:

- Ministry of Water Resources and Irrigation (MWRI)
- Ministry of Agriculture and Land Reclamation (MALR)
- Ministry of Health and Population (MOHP)
- National Organization of Potable Water and Sanitary Drainage (NOPWASD) of the Ministry of Housing, Utilities, and Urban Communities (MHUUC)
- Egyptian Environmental Affairs Agency (EEAA)

Under the benchmark, the following major activities were conducted:

- Established a conceptual framework, including the identified critical areas of urban wastewater management, to guide the policy development.
- Organized an APRP/MWRI Wastewater Task Group to carry out benchmark activities. The group, composed of eight representatives from the five cooperative ministries and agencies, routinely met every 2-3 weeks, and organized four workshops to discuss policies and monitor benchmark activities.
- Conducted, for the first time in Egypt, a sampling program for the water microbial features in Salaam Canal, its feeding drains, and the effluents of the Mansoura wastewater treatment plant.
- Participated in a MOHP-WHO sponsored wastewater irrigation training to promote public awareness.
- Conducted international study tours to Jordan (a neighboring country with an equivalent economic development level) and California, USA (renown for its stringent water quality standards and the most advanced wastewater treatment technology) to gain from their wastewater management experiences.

- Organized inter-ministry policy development by providing each party with policy outlines and technical discussions. Appendices 1-6 are the representatives' reports from each cooperating ministry or agency. This document summarizes the recommended policies and procedures on behalf of the APRP/MWRI Wastewater Task Group.

1.5 Organization of the Report

Chapter 1 provides the background, identifies the participating parties, and summarizes the major activities that have been conducted under this benchmark. Chapter 2 describes the general situation of wastewater discharge and reuse in the Nile Delta, and identifies the critical issues to be addressed in this document. Chapter 3 presents the development status and performance levels of wastewater treatment plants, and recommends two policies with accompanying procedures for improvement. The chapter also provides one policy recommendation for improved industrial wastewater treatment at the source. Chapter 4 reviews health concerns associated with wastewater irrigation, provides a brief development history of wastewater quality standards, and suggests three policies and accompanying procedures for improved wastewater effluent quality control and drainage quality monitoring. The chapter also, for the first time, publishes the sampling results of Salaam Canal's water microbial features. Chapter 5 addresses the reuse of wastewater and recommends four reuse policies and accompanying procedures. Chapter 6 presents a policy and accompanying procedures for improved inter-ministry cooperation in urban wastewater management. Chapter 7 presents the conclusions.

This document includes the following six appendices:

Appendix 1	Wastewater Treatment in Egypt (by NOPWASD representatives)
Appendix 2	Health Impact and Water Quality Standards in Wastewater Irrigation (by MOHP representative)
Appendix 3	Wastewater Irrigation for Forest Plantation (by MALR representative)
Appendix 4	Industrial Wastewater Management (by EEAA representative)
Appendix 5	Wastewater Effluents Administration and Management (by MWRI representative)
Appendix 6	Priorities for Improving Drainage Water Quality in the Delta (by MWRI representatives)

2. Existing Wastewater Discharge and Reuse

The discharge of wastewater, particularly the large volume of concentrated urban sewage, in agricultural drains poses an increasing pressure on water quality in the Delta. Since construction of the High Aswan Dam, the seasonal Nile floods, which frequently flushed the Delta's low lands, no longer reach the region and pollutants carried by wastewater have accumulated in the drain system. This was reflected by the sudden appearance of drainage contamination problems in the early 1990s when six out of the 26 main drainage reuse pump stations were forced to shut down periodically due to unacceptably poor drain water quality. Today, an amount of 2 - 3 billion cubic meters of agricultural drainage water is lost per year due to the discharge of wastewater. Obviously, Egypt cannot afford a loss of this magnitude in the future.

2.1 Discharge and Reuse Patterns in the Delta

Figure 1 below shows the existing wastewater discharge and reuse patterns in the Delta. The types of reuse squared by dotted lines are not available in the current system. They are needed and will be discussed and recommended in later chapters.

Two Mixing Processes

As shown in Figure 1, wastewater effluents enter the Nile irrigation system by two mixing processes: to mix with agricultural drainage in drains (MIX-1), and to mix with freshwater in canals as part of the drain water (MIX-2). Each mixing disperses the pollutants carried by wastewater to a larger water body and degrades the water quality of the entire system. Untreated sewage in drains also has the chance to intrude into the irrigation system through drainage reuse. These two mixing processes will continue to involve water quality problems unless wastewater is disposed of at destinations other than drains, which is impractical in the Delta.

Wastewater Treatment

Treatment is fundamental and ultimate to wastewater management. If all the wastewater could be satisfactorily treated before dumping into drains, there would be no water quality problem in the rest of the water cycle. However, full treatment of wastewater is not possible in the near future, given the nation's economic development level. Even in existing plants, operations are inefficient, and the environmental improvements from their operations are not strongly evident.

Unrestricted Irrigation System

The Nile irrigation system delivers water for unrestricted irrigation use. Fresh Nile River water and canal water, after being mixed with drainage water, is used without crop restrictions. Such unrestricted irrigation makes operation and management easier, but the system is vulnerable from wastewater effluents. Maintaining uniformly high water quality for unrestricted irrigation and increasing the use of wastewater effluents and other low quality water in the same system are conflicting goals. A central question is how to minimize the wastewater entering the unrestricted irrigation system by diverting the wastewater for use in other systems.

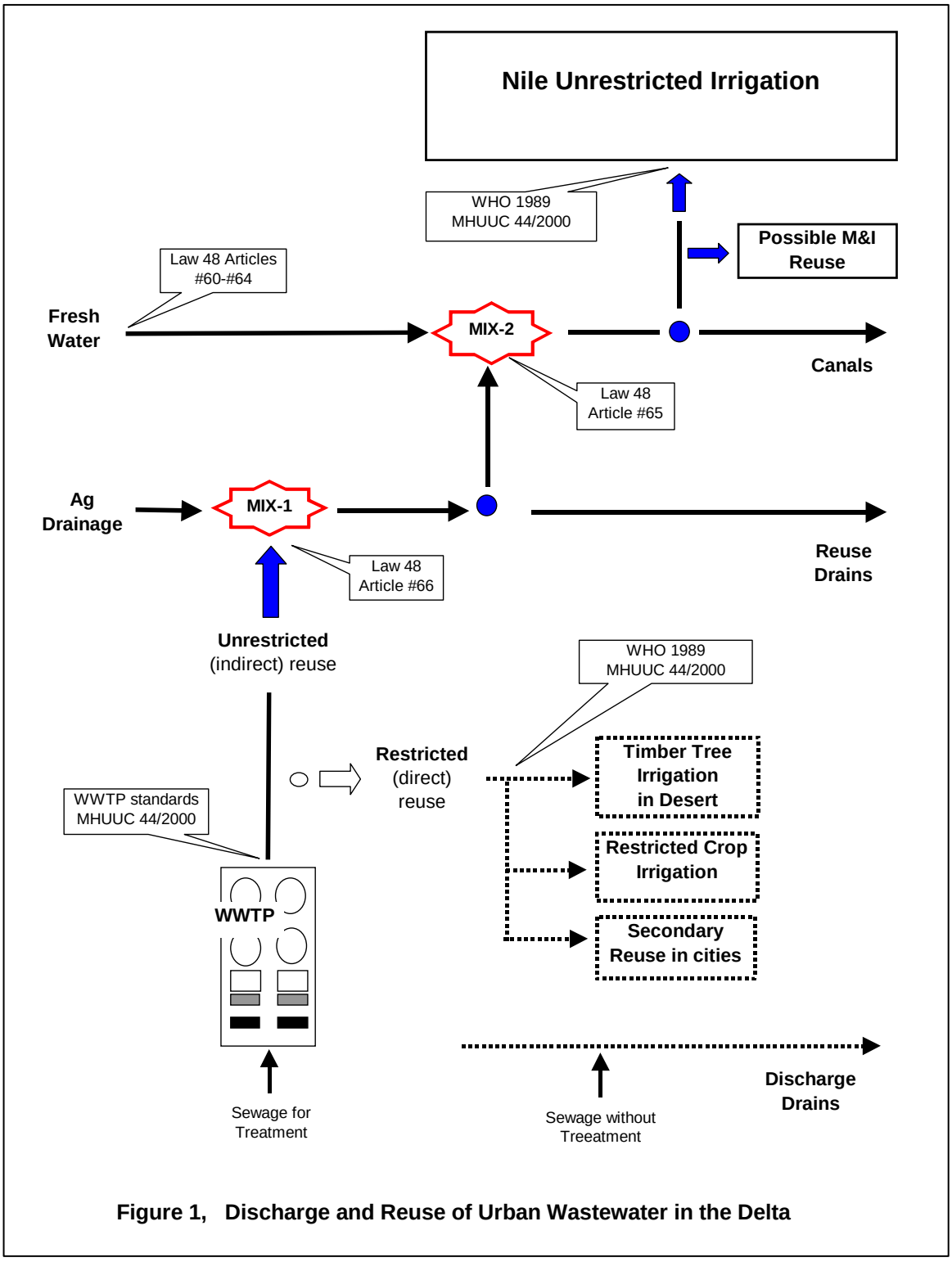

Figure 1, Discharge and Reuse of Urban Wastewater in the Delta

Intruded wastewater components (not toxic industrial waste) in the Nile irrigation system are likely after diluting several times and possibly after several days of detention in the drains and canals. This indirect reuse is different from the direct wastewater irrigation cited in international literature. Similar to natural river systems, biological assimilation occurs in the extended canals and drains in the Delta. This fundamental fact shouldn't be overlooked when assessing Egypt's wastewater discharge and reuse.

Restricted Wastewater Reuses

Restricted wastewater reuse is not well developed in Egypt. As indicated in Figure 1, they could include:

- Irrigating timber trees in the deserts;
- Irrigating crops tolerable to the quality of wastewater effluents; and
- Irrigating green lands in the cities.

The pilot programs of wastewater tree irrigation in the desert conducted by the Afforestation Department of MALR, have proven feasible and promising. The benefits of the timber-tree irrigation are multi-fold, but the primary benefit is that it provides an effective way to exhaust the unwanted wastewater entering the unrestricted irrigation system.

Laws, Regulations, and Standards

Law 48 is the main governing law for water quality management in Egypt. Law 48 sets specific water quality standards in Articles 66 and 65 for the mixing points MIX-1 and MIX-2 respectively, in addition to Articles 60-64 for general waste discharge in canals (Figure 1). Although Law 48 does not specify standards on intestinal nematode eggs - the major threats to human health from wastewater, the pioneer legislators did recognize the importance of the two mixing processes in Egyptian water quality management. Both WHO 1989 Guidelines and the newly issued MHUUC Ministerial Decree 44/2000 distinguish water quality requirements for unrestricted and restricted irrigation. However, some parts of the two standards seem overly restrictive in the Nile context. Compliance with these laws, regulations, and water quality standards remains to be implemented.

Inter-ministry Cooperation

The management of urban wastewater involves many stakeholders including government ministries and the private sector. There are outstanding issues and questions concerning authority, responsibility and cooperation among these stakeholders.

2.2 Identified Critical Issues

The APRP/MWRI Wastewater Task Group has identified the following critical issues for improved management of urban wastewater discharge and reuse:

Wastewater Treatment

- Prioritization of plant construction at given budget levels.
- Making existing treatment facilities function effectively.
- Treating industrial wastewater at sources.

Health Concerns and Wastewater Quality Standards

- Recognizing pathogenic threats to human health in wastewater irrigation.

- Understanding wastewater quality standards, MHUUC Ministerial Decree 44/2000, and MOHP role in wastewater quality inspection and regulatory development.

- Assessing the water quality status of the Salaam Canal.

Discharge and Reuse of Wastewater Effluents

- Separating untreated sewage flows from reuse drains.
- Continuing MWRI effort in drainage quality monitoring.
- Opening restricted irrigation on selected crops.
- Using wastewater effluents to grow timber trees in desert areas.
- Encouraging secondary wastewater reuse in cities.

Inter-ministry Cooperation

- Establishing a cooperation framework including division of responsibilities and financial mechanisms for cooperation.

3. Wastewater Treatment

The Government of Egypt has made major achievements in constructing municipal wastewater treatment plants in the past two decades. Currently, sewage treatment plants serve 55% of the population in towns and cities. Table 1 lists the operating wastewater treatment plants in the year 2000. There are 59 primary or secondary treatment plants operating with a total capacity of 6.2 mcm/day (or 2.3 bcm/year); of these plants, 52 plants with a capacity of 2.7 mcm/day were constructed under NOPWASD management, and the remaining seven were constructed under CGOSD and AGOSD management.

Table 1. Operating Wastewater Treatment Plants in Year 2000

	Governorates or Cities	Number of Plants	Operating Capacities (1,000 m^3/day)
1	**Damiatta**	3	127
2	**Daquahlia**	3	138
3	**Sharquia**	4	130
4	**Qalubia**	4	188
5	**Kafr ElSheikh**	1	19
6	**El Gharbia**	3	161
7	**El Beheira**	5	88
8	**El Monufia**	4	104
9	**Matrouh**	1	25
10	**Port Said**	1	190
11	**El Ismailia**	1	90
12	**El Suez**	1	130
13	**El Giza**	3	900
14	**El Fayoum**	1	40
15	**Beni Suief**	1	10
16	**El Menia**	2	60
17	**Assyout**	2	60
18	**Sohag**	1	22
19	**Qena**	1	30
20	**Luxor**	1	26
21	**Aswan**	1	21
22	**Greater Cairo**[1]	5	3,230
23	**Alexandria**[1]	2	317
24	**North of Sinai**	1	50
25	**South of Sinai**	5	31
26	**New Valley**	2	22
		59	**6,209** (2.27 bcm / year)

Note: 1) 5 plants in Cairo under GCGOSD, 2 plants in Alexandria under AGOSD, and another 52 plants at 2.662 mcm/day under NOPWASD.

2) Data source: Table 1 in Appendix 1.

3.1 Plant Construction Priorities

NOPWASD has a plan to achieve a daily treatment capacity of 4.7 mcm by the end of year 2007, as indicated in Table 2, Appendix 1. During 2000, a total capacity of 2.7 mcm/day was realized. The remaining capacity of 2 mcm/day targeted for operation by 2007 is equivalent to building 20 plants with an average capacity of 100,000 mcm/day (or 100 plants with an average capacity of 20,000 mcm/day) over the next seven years. Is this target achievable?

According to NOPWASD (Table 2, Appendix 1), an amount of LE 9.1 billion was spent to construct the current operating capacity of 2.7 mcm/day. Therefore, construction of an additional 2.0 mcm/day capacity would require approximately LE 6.7 billion. Over a seven-year period, this would entail an average annual investment of nearly LE 1 billion, assuming costs do not escalate. Table 2 below includes the actually allocated budgets to the wastewater sector during the past eight years. Higher budgets were allocated during the late 1990s. The average annual budget was approximately LE 1.3 billion. Financially, the plan seems achievable if the 1990s annual budget scale were continued in the coming seven years.

Table 2. NOPWASD Investments in Wastewater Treatment

Year	Actual Investments (million LE)
1992-1993	392
1993-1994	684
1994-1995	960
1995-1996	1,300
1996-1997	2,428
1997-1998	1,559
1998-1999	1,616
1999-2000	1,524
Total	**10,464**
Average Annual	**1,308**

Note: The 1996-1997 figure includes USAID funds on Canal Cities Projects.

However, the plan is not necessarily a construction completion schedule. Past construction history shows that the annual budget was first used for opening new projects instead of completing on-going constructions. A project could take 3 to 5 years longer to complete than scheduled. The rationale behind this construction approach was to spread the budget to as many projects as possible for territorial equity reasons. Governorates attempt to include every locally demanded project, urgently needed or not, in the NOPWASD plan. NOPWASD is not in a position to reject these governorate demands.

This territorial equity driven construction rationale should be replaced by a prioritized national plan for improved environmental and drain water quality. Under this benchmark, NOPWASD and MWRI representatives exercised their construction priority lists, as shown in Appendix 1 and Appendix 6, respectively. However, the two appendices used different criteria to sort preferences, which resulted in two different lists. The lists more accurately convey overall plans than prioritized lists for a given time period and financial budget. Construction priority issues need to be agreed to by both NOPWASD and MWRI.

Policy #1 ***In wastewater treatment plant construction, the territorial equity rationale must be replaced by a broader national interest. The criteria for prioritizing the construction of wastewater treatment plants should be:***

- ***To protect human health (mainly drinking water sources);***
- ***To sustain agricultural drainage reuse; and***
- ***To maintain ecological balance in lakes and on seashores.***

Procedures *NOPWASD, together with MWRI, MOHP, and EEAA, should prepare a prioritized construction and implementation plan for wastewater treatment plants for the period 2000-2007, based upon the above mentioned priority criteria, available budget, and current on-going construction activities.*

3.2 Performance of Constructed Plants

Egypt currently has 59 operating wastewater treatment plants, compared to 26 plants in 1982. However, the drain water quality improvement from these treatment plants is not strongly evident. One reason is that many of the plants are operating at a lower performance level than designed.

Primary causes for the low performance include:

- Non-skilled plant operators;
- Inadequate O&M budgets;
- Lack of spare parts;
- Over-flow without treatment;
- Insufficient use of chlorine disinfecting; and
- Lack of effluent quality control.

Even with the low performance, the O&M costs of these treatment plants represent a financial burden to the GOE. With the construction of more treatment plants in the next 5-7 years, the financial requirements will increase. Therefore, effective expenditures for wastewater treatment plant operations should be of major concern.

Policy #2 ***A urgent need in wastewater treatment is to improve the effectiveness of those treatment plants already constructed and operational.***

Procedures *NOPWASD should create more educational and practical opportunities for the development of Egyptian wastewater treatment professionals. WWTP operation codes, operator license system, and effluent quality control must be enforced. The corporation model of the Public Economic Authority, as a transition to full privatization of wastewater services, should be extended to more governorates, and a user-pays, self-reliant finance mechanism must be exercised in those authorities. NOPWASD should also strengthen public awareness education about urban wastewater services.*

3.3 Industrial Wastewater Treatment

Industrial wastewater, as part of the wastewater generated in urbanized areas, is often mixed with domestic wastewater in sewers or directly discharged to drains without pre-treatment in the Delta. Chemical components of industrial wastes are toxic to the bacteria needed in activated sludge treatment processes. Untreated industrial wastewater destroys the normal operation of biological treatment processes. This has occurred in the Shoubra Kheima

treatment plant, where raw industrial waste from the region's numerous small industries impact the effectiveness of the activated sludge treatment processes.

The quantity and characteristics of industrial wastewater generated in the Delta region was not available to the Wastewater Task Group. But for the area neighboring the Salaam Canal, described in Appendix 5, the industrial wastewater discharged to the Hadous and Serw drains (the two feeding drains to Salaam Canal) accounts for 123 mcm/year and 47 mcm/year, respectively.

The newly issued MHUUC Ministerial Decree 44/2000 sets quality standards for industrial and commercial wastewater discharge into public sanitary sewers. The EEAA has started several education programs for a Compliance Action Plan (CAP) in the region, although the efforts are minor and insufficient. The task group studied the industrial wastewater issues through the cooperation of EEAA in the Phase I period, and the cooperation will be extended to the Ministry of Industry and other concerned parties in the next phase.

Policy #3 ***Minimize the discharge of industrial wastewater to municipal sewers and agricultural drains. Agricultural drains are not open dumping sites for industrial wastes, and pre-treatment of industrial toxic wastes at the source is a must.***

Procedures *EEAA should extend its effort of restricting industrial waste dumping in the Nile River to the agricultural drains and city sanitary sewers. New industries, either large or small, must meet the at-source treatment requirements for permitted operation. MWRI, in cooperation with EEAA and MOHP, should establish more restrictions on industrial wastewater discharge in agricultural drains.*

4. Health Concerns and Wastewater Quality Standards

The primary constraint to wastewater reuse in irrigation is the human health risk from pathogens carried by wastewater. Effluent water quality standards and regulatory efforts are mainly driven by human health concern.

4.1 Pathogenic Threats to Human Health

Urban wastewater carries the full spectrum of excreted human pathogens, including helminthes, protozoa, bacteria, and viruses. Pathogens can survive in the environment for a long time. Among the four types of pathogens, helminthes represent the most effectively transmitted pathogens in wastewater irrigation. Continuous exposure and infection by helminthes can result in a buildup of worm loads in the human body -- there is little or no immunity to helminthes. Common types of helminthes in developing countries are ascaris and trichuris. Appendix 2 presents information and an analysis of human health impacts and water quality standards in the international and Egyptian contexts.

Wastewater irrigation involves the risk of disease transmission. Pathogens in human waste are the main threat. However, few credible epidemiological studies of quantifiable human health effects have been carried out. Whether or not people actually get infected after working in wastewater irrigation fields or eating wastewater-irrigated vegetables depends on many factors, such as the infectious dose, state of immunity, and contamination routes. People should not panic about wastewater irrigation which has been practiced for thousands of years and is increasingly applied today in many water-short countries. Simple but effective prevention measures for individuals are avoiding eating raw vegetables and avoid direct contact with wastewater.

Policy #4 ***The primary threats of wastewater irrigation to human health are pathogenic organisms found in wastewater including bacteria, viruses, protozoa, and helminthes.***

Procedures *MOHP, in cooperation with MWRI and NOPWASD, should strengthen public awareness education on the human health risks of wastewater irrigation. All cooperating ministries should establish a better understanding of the various potential mitigating measures and their applications under the Egyptian conditions. MOHP should increase its scientific research to examine human health risks from wastewater irrigation in the Egypt. NOPWASD should pay more attention to the effective removal of pathogens in treatment plants.*

4.2 Wastewater Quality Standards

California wastewater treatment requirements

Wastewater treatment requirements were first issued by the California State Health Department in 1918 and are still in effect. The regulations restricted wastewater irrigation

on salad crops by a quality standard of less than 2.2 coliform bacteria counts per 100 ml. This is extremely stringent, compared to that of 5,000/100 ml in Egyptian Law 48 and 1,000/100 ml in WHO 1989 Standards. Today, California uses tertiary treatment to achieve the standard.

WHO 1973 Guidelines

The World Health Organization (WHO) published public health policy guidelines on wastewater reuse. The guidelines relaxed the California standards by allowing effluents to contain 100 coliform bacteria counts per 100 ml in 80% of the samples.

Engleburg Meeting

A group of international experts re-assessed the practice and standards of wastewater irrigation in developing countries during a meeting held in July 1985 in Engleburg, Switzerland. The assessment established an understanding of human infection risks with wastewater irrigation: high risk with intestinal nematodes, moderate risk with bacterial infections, and minimal risk with viral infections. They found that the risks associated with trematodes and cestode infections, schistosomiasis, clonorchiasis, and taeiasis depend on local circumstances.

WHO 1989 Guidelines

The conclusions from the Engleburg Meeting were modified by WHO and published as WHO Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture in 1989. The Guidelines are internationally recognized, and have been adopted by many countries as the foundation for their own standards. The core contents of the guidelines are:

- For unrestricted irrigation of all crops including vegetables, the delivered water should include (1) no more than one nematode egg (ascaris, trichuris, or hookworm) per 1,000 ml, and (2) a geometric mean no more than 1,000 fecal coliform bacteria per 100 ml.
- When raw-eaten crops are excluded (restricted irrigation), only the above nematode standard (1) is required following a 5-day wastewater detention period in a stabilized pond.

Law 48/1982

Law 48/1982 is the super law regarding water quality management in Egypt. As mentioned in Chapter 2, the Law is unique compared to other standards or requirements by specifying the quality requirements of discharging flow at the two mixing points: effluents to drains and drainage to canals. This relates well the practice of wastewater effluent disposal and drainage reuse in Egypt. In the context of water microbial features, the Law set 5,000/100 ml coliform bacteria counts as discharge permit at the two mixing points. It is less restrictive than the WHO Guidelines, but better fits the quality reality in the Nile watercourses. Unfortunately, implementation and compliance with the Law has been unsatisfactory.

MHUUC Ministerial Decree 44/2000

Recently, the MHUUC, with the agreement and support of MOHP, issued Ministerial Decree 44/2000 (Concerning Amendment of the Executive Regulations of Law 93/1962 Pertaining to Discharging Liquid Effluents). The decree set a standard of 1,000/100 ml coliform bacteria counts for secondary treatment effluents, and 5 eggs and 1 egg of intestinal nematodes for primary and secondary treatment effluents, respectively. The decree strongly opposes the use of wastewater in irrigating vegetables, fruits, and other crops possibly eaten raw.

The California standards and WHO 1989 Guidelines represent two different schools of thought on water quality requirements in the international arena. The California standards are very stringent on fecal coliform bacteria, while the WHO experts considered such a conservative attitude on health unjustifiable in developing countries. WHO emphasizes the importance of helminthes while California does not mention helminthes in the standards. These variances demonstrate that water quality standards are relative to the level of economic development and that standards should reflect the local conditions.

The law 48 and MHUUC Decree 44/2000 together provide water quality standards related to wastewater discharge and drainage reuse. They may not be perfect on particular technical settings, but they are the authorized standards and should be respected by all involved parties.

The Nile freshwater prevailingly presents a higher coliform bacteria count than 1000/100 m. this raises a question of whether it is necessary, as well as possible, to treat the wastewater to a cleaner level than the freshwater. A standard of 5 intestinal nematode eggs per 1,000 ml for the primary treatment, as in MHUUC Decree 44/2000, seems to lack a scientific base. Many local MOHP or MWRI offices may not have adequate capability to conduct a test for intestinal nematode eggs. The classification of the different Nile watercourses for water quality standards application and opportunities ahead. Each cooperating ministry or agency has a significant contribution to make to wastewater management in Egypt.

Policy #5 ***The water quality requirements issued in Law 48 and MHUUC Ministerial Decree No 44/2000 represent the authorized standards in Egypt. All involved ministries and agencies should better recognize the role of MOHP in wastewater quality inspection and regulatory development.***

Procedures *MOHP should accelerate technical capacity building at both national and local levels for the increasingly complicated quality monitoring and inspection tasks. MWRI should classify the Nile watercourses for different water quality standard applications. MOHP, in cooperation with MWRI and other involved ministries, should develop clear responsibility lines in monitoring wastewater treatment plants, mixing points in drains and canals, lakes and seashores, unrestricted and restricted irrigation fields, and other sites of particular interest.*

4.3 Salaam Canal Water Quality

The MOHP Environmental Monitoring and Occupational Health Study Center conducted a sampling of the Mansoura treatment plant effluents; drain water in the Faroscour, Serw, and Hadous drains; and Salaam water at intake, drainage mixing points, and the Grand Siphon.

In the sampling, pathogens including total bacteria, fecal bacteria (vibriocholerae, salmonella typhoid, and other type salmonella), escherichia coil protozoa, and helminthes were analyzed.

Tables 3 presents the sampling results and the relevant standards of Law 48, MHUUC Decree 44/2000, and WHO 1989 Guidelines.

The large numbers of intestinal helminth eggs detected in Salaam water are a cause for great concern. All samples showed exceedingly high intestinal helminth eggs, particularly ascaris, taenia, hookworms, and hymenolepis diminuta (Table 3). For instance, there were 720 ascaris eggs per 100 ml checked in Salaam after Hadous mixing, while WHO 1989 Guidelines and MHUUC Ministerial Decree 44/2000 allow only 1 egg per 100 ml for general (unrestricted) irrigation. This raises a question; does the Nile freshwater also contain high levels of helminthes? According to WHO information sources, water bodies in Jordan and several neighboring countries also reveal similar high level of helminthes. MOHP should conduct more research to evaluate the actual seriousness of the high helminth egg figures checked in Salaam Canal.

Table 1. List of drainage water reuse projects that fall under criteria A & B

No.	Project / Drain Name	Drain(s)	Mixing Canal	Pollution Type	Use D.S.	Mixing Quantity	Waste Water Treatment Plants		
							Number	Capacity	
						BCM		m3/day *1000	BCM/year
1	**El Salam Canal Project**								
		Bahr Hadous	El Salam Canal	A-Do-In	I	1.1	36	535	0.195
		El Serw	El Salam Canal	A-Do	I	0.6	7	56	0.020
		Farskour	El Salam Canal	A-Do-In	I	0.3	3	24	0.009
2	**El Garbia Drain**	El Garbia	Bahr Tera & Rawina	A-Do-In	I	0.876	9	152	0.055
3	**El Wadi and Mahsama Reuse**	El Wadi	Al Ismailia Canal	A-Do	I&D	0.232	2	20	0.007
		Mahsama	Al Ismailia Canal	A-Do	I&D		1	90	0.033
4	**Behera Governorate**	El Omoum drain/Sherishera	El Noubaria Canal	A-Do-In	I&D	1	4	60	0.022
		Edco	El Mahoudia Canal	A-Do-In	I&D	0.2	6	196	0.072
5	**Qlabsho Project**	No 1 Lower	Zaian + 15th May Canals	?	?	*0.33*	3	60	0.022
		No 1 Upper	Domiatta Branch +Zaian + 15th May Canals	A-Do-In	?	*0.33*	3	60	0.022
		No. 2	Zaian + 15th May Canals	?	?	*0.33*	1	20	0.007
6	**El Mouheet Drain**		Rossetta Branch (Nile)	A-Do-In	I&D	0.438	6	980	0.358
7	**Monoufia Governorate**								0.000
	East Monoufia	El Qaranein	El Rayah El Abbassy	A-Do	I&D	0.03	1	20	0.007
		El Attfe	El Rayah El Abbassy	A-Do	I&D	0.03	3	40	0.015
	West Monoufia	Sabal	Rossetta Branch (Nile)	A-Do-In	I&D	0.07	5	60	0.022
		Tala	Rossetta Branch (Nile)	A-Do-In	I&D	0.1	3	60	0.022
8	**Meet Yazeed Canal**	Mahleet Rough Catchement	Meet Yazeed Canal	A-Do-In	I&D	?	4	42	0.015
9	**Bahr El Baqar Drain**	Qalubia	El Wadi El Sharki Canal + Lake Manzala	A-Do-In	I&D	0.307	31	990	0.361
		Belbaise	Lake Manzala	A-Do-In			8	2,202	0.804
		Bahr El Baqar Drain	Lake Manzala	A-Do-In			8	80	0.029
10	**Bahr Nashart Drain**	Bahr Nashart	10 Branch Canals	A-Do-In	I	0.21	5	152	0.055
11	**Eatai El Baroud Drain**		El Kandag El Sharky Canal to Mahmoudia Canal	?	I&D	0.092	1	10	0.004
Total						**6.575**	**150**	**5,909**	**2.157**

Pollution Type
A: Agriculture
Do: Domestic
In: Industrial

Downstream Use
I: Irrigation
D: Drinking

?: Missing Information

5. Discharge and Reuse of Wastewater Effluents

5.1 Separation of Wastewater

The full treatment of wastewater is far from reality. Agricultural drainage reuse is a mainstay and will continue in the Delta. An alternative to agricultural drains as wastewater dumping sites is not available and long-distance diversion of wastewater is impractical. Given these factors, a central need for separating or minimizing wastewater from general irrigation water remains. In this respect, MWRI faces a big challenge. Separation of wastewater will require the following measures:

- Classifying drains into two categories: *reuse drain* and *discharge drain*.

  Reuse drains have water acceptable for irrigation reuse. Untreated sewage should be kept out of reuse drains as much as possible. Discharge drains collect water that is of low quality without usability and should be discharged either to the sea or the desert. Each of the three Delta regions could have one or two *discharge drains* to collect and transport unwanted wastewater.

  For example in the East Delta, the Bahr Bagar drain carries a large volume of untreated sewage from Cairo and Kalubya governorates. Water in Bahr Bagar has no reuse value and the drain functions as a discharge drain. Reuse along the Bahr Bagar main drain should be prohibited. Agricultural drainage in the basin's branch drains can be intermediately reused. The huge effluent from the Gebel El Asfa WWTP, which is clean and expensive, should be kept out of Bahr Bagar to maintain its reusability.

- MWRI has adopted a policy to promote the reuse of cleaner branch drain water before the water goes to a polluted main drain. This policy should be aggressively implemented.

- Developing restricted wastewater irrigation to reduce the amount of wastewater entering the large-scale unrestricted Nile irrigation system. This will be discussed in detail in the following sections.

Policy #6 ***Separation of wastewater from agricultural drains is critical to sustain general irrigation in the Delta. Efforts in this direction, including drain function classification, intermediate drainage reuse, and wastewater tree-irrigation in the desert, should be recognized and supported.***

Procedures *MWRI, in cooperation with NOPWASD, MOHP, and local municipal authorities, should organize an overall drain classification program for the Delta. MWRI, in cooperation with local municipal authorities, should assess and implement, in steps, necessary penalties for discharging untreated wastewater into classified reuse drains and using drain water from classified discharge drains.*

5.2 Drainage Quality Monitoring

As discussed in Appendix 5, continuous and improved drainage quality monitoring is needed for effective management of irrigation quality. MWRI started its drainage monitoring system for combating drainage salinity issues two decades ago. The monitoring program has been expanded to include broader water quality content since the early 1990s. With the current monitoring program, MWRI has effectively sustained large-scale drainage reuse and unrestricted irrigation in the Delta. MWRI has established a qualified technical team and adequate facilities for water quality monitoring and management after the second mixing point (MIX-2).

Policy #7 ***The MWRI drainage-monitoring program has functioned as a main technical support in Delta region's water quality management during the past two decades. The program should be encouraged and continued.***

Procedures *MWRI, in cooperation with MOHP and EEAA, should upgrade the existing drainage monitoring program for more competent wastewater-related monitoring work.*

5.3 Restricted Irrigation

The large-scale unrestricted irrigation in the Delta is threatened by wastewater entering the system. To protect the unrestricted irrigation, restricted irrigation using pure or partially pure wastewater for tolerable crops should be developed. Restricted wastewater irrigation has been practiced in many countries for conserving freshwater.

Both WHO 1989 Guidelines and MHUUC Decree 44/2000 prohibit wastewater irrigation on vegetables, fruits, and raw-eaten salad crops, but allow reuse of wastewater effluents on restricted crops. The MHUUC Decree 44/2000 presents detailed specifications on what quality of water is appropriate for which crops and under what conditions, as shown in Table 4 below. The decree requires environmental impact assessment for restricted crop irrigation. For the Delta case, cautious evaluation of the possible negative impact of wastewater irrigation on neighboring groundwater aquifer is particularly important.

Policy #8 ***Follow the MHUUC Ministerial Decree 44/2000 and WHO 1989 Guidelines to initiate restricted irrigation for the safe use of wastewater on selected crops.***

Procedures *MALR, in cooperation with MWRI and MOHP, should plan crop zones for different quality irrigation sources in the Delta. MALR and MWRI should test pure wastewater irrigation for selected crops with cautious assessment of the possible groundwater contamination in neighboring areas.*

Table 2. Summary of Estimated WWTP Capital Costs in MWRI - Priority Areas in the Delta

Project	No. of WWTP	Capacity 99/2000	Estimated Capital Cost L.E million	Financial Allocation 99/2000	Implement till now	Required remainder allocation	WWTP Construction Status			
							Operating	Constructed	In Construction	Proposed
1) El Salam Canal	46	615	1,493	136	881	612	4	5	22	15
Bahr Hadous Drain	36	535	1,186	107	715	471	3	5	17	11
Lower Serw Drain	7	56	187	20	85	101			4	3
Faraskqour Drain	3	24	120	9	80	40	1		1	1
2) El Gharbia Drain	9	152	352	52	232	120		1	8	
3) El Wady & El Mahsama	3	110	119	12	69	50	2		1	
4) Bahera Gov. Drains	10	256	717	34	540	177	1	2	7	0
El Omoum Drain	4	60	301	18	195	106		1	3	
Edko Drain	6	196	416	16	345	71	1	1	4	
5) Qlabsho Project	7	140	290	43	196	94		1	6	
6) El Mouheet Drain	6	980	1,729	18	1,646	83	2		3	1
7) Monoufia Gov. Drains	12	180	684	61	454	230	1		11	
West	8	120	412	44	246	166			8	
East	4	60	272	17	208	64	1		3	
8) Meet Yazeed	4	42	162	16	121	42			4	
9) Bahr El Baqar	47	3,272	1,580	146	715	865	3	3	12	29
Qalubia Drain Basin	31	990	1,040	25	515	525	1	3	3	24
Belbaise	8	2,202	297	90	97	200	2		4	2
Bahr El Baqar	8	80	243	32	103	140			5	3
10) Bahr Nashart Drain	5	152	348	12	301	47	1		3	1
11) Eatai El Baroud Drain	1	10	NA				1			
Total	**150**	**5,909 2**	**7,474 BCM**	**528**	**5,154**	**2,320**	**15**	**12**	**77**	**46**

5.4 Timber Forest Irrigation in the Deserts

As described in Appendix 3, the Afforestation Department of MALR has successfully launched a campaign of wastewater effluent irrigation on timber trees over the past 6 years. Six pilot plantation projects with a total area of more than 2,000 feddans were implemented in the deserts from Upper Egypt to the Delta. The timber trees, particularly eucalyptus, acacia, mulberry, and khaya, have grown fast, are healthy, and have good economic return expectations. For the first time in modern Egyptian history, green forests appear in the deserts.

MALR policy on wastewater reuse: Use the wastewater effluents for growing timber trees in the desert, and do not use the water for fruits, vegetables, and field crops (Appendix 3). The policy is well consistent with the WHO 1989 Guidelines and MHUUC Ministerial Decree 44/2000.

Appendix 3 explains the rationale behind the policy:

- Egypt needs home-produced timber trees to reduce its reliance on expensive foreign lumber imports;
- Egypt needs to maintain the quality and reputation of its Nile water irrigated fruits and vegetables in the international agriculture market;
- Egypt's wastewater treatment program remains at the primary or secondary treatment level, and only in the future when more advanced and qualified treatment is adopted, could the effluent be used for ornamental plants, cut flowers, and fiber crops; and
- Egypt has not reached the point where water scarcity demands that fruits, vegetables, and raw-eaten salad crops have to be irrigated by sewage.

Wastewater irrigation of timber trees in the desert sounds promising. Appendix 3 includes a preliminary financial analysis of wastewater tree irrigation and answers questions raised by water sector representatives regarding the validity and eligibility of the proposed policy. Recently, MALR has decided to make 16,000 feddans of desert lands for timber tree plantation, and majority of the lands will be for private investors.

Assuming timber trees consume a similar quantity of water as general field crops (5000 m3 per feddan per year) and 50% of the wastewater effluents (1.2 bcm) are used for trees, a rough estimate of 240,000 feddans of timber trees could be grown in Egypt by using treated wastewater. That area is equivalent to 4 or 5 irrigation districts, and the expected economic return would be a source of revenue for the country.

Policy #9 ***Wastewater effluent irrigation on timber trees in the desert is an environmentally and economically sound reuse. The effort should be recognized, encouraged, and supported.***

Procedures *MALR should expand its current effort to promote wastewater irrigation of timber trees in the desert by strengthening public awareness education programs and by providing stronger economic incentives to attract private sector participation. MALR and MWRI should better cooperate to conduct environmental impact assessment, particularly groundwater*

impact evaluation, for wastewater irrigation in timber tree plantation.

5.5 Urban Greenland Irrigation

Wastewater irrigation for urban greenland development is a step towards non-agricultural secondary reuse in cities. Given the heavy agricultural activities in the Delta, the potential for forest development in the Delta is limited. But newly developed cities and towns badly need public parks and street trees to build their green areas. Wastewater effluents should have a great reuse potential for this purpose.

Again, the MHUUC Decree 44/2000 provides wastewater reuse specifications for park grass, street trees, and other urban green lands to minimize human health risks.

The Afforestation Department of MALR, with the Dakhalia Governorate's cooperation, is planning a pilot program for wastewater tree irrigation on a 5-km length of the Mansoura highway. This kind of non-crop reuse represents a new way to dispose and absorb urban wastewater in the Delta, and should be encouraged and supported.

Policy #10 ***Use wastewater effluents to grow green lands in cities and towns in the Delta.***

Procedures *The Afforestation Department of MALR, in cooperation with MWRI and Dakhalia Governorate, should conduct a pilot program using wastewater effluents to grow street trees in Mansoura City. The pilot work should include an environmental impact assessment.*

6. Inter-ministry Cooperation

Water quality management demands the involvement and cooperation of government agencies, the private sector, and water users. Under this benchmark, representatives from five ministries organized a wastewater task group to address the status and problems of current inter-ministry cooperation in wastewater management (Appendices 1-5). The lack of a cooperation framework and financial mechanism was one of the major problems identified.

An established framework is important. In California, people work together under CALFED, a government-sponsored environmental program. The program involves 15 state and federal agencies and numerous private participants who plan actions to restore ecological health and improve water management. Activities are directly integrated into programs of the involved departments or agencies, and cooperation is integrated into regular office functions. The state and federal governments co-finance CALFED planning and coordination activities, and local beneficiaries, either users or city councils, pay the implementation costs. The terminology used in California refers more to obligation and contribution than to authority and responsibility.

In Egypt, many inter-sector cooperative activities are organized through special steering committees. These committees are not usually given legal status for decision-making. Inter-ministerial activities are regarded as additional activities, not integrated into the regular office operations. Without a cooperation framework, the scope of authority and responsibility is vague and fragmented. More than one ministry may declare authority in a particular field, while no ministry demonstrates concern in carrying out responsibilities in another field; and the effort made by one party may be inconsistent with other parties' interests.

Policy #11 ***Inter-ministry cooperation is the foundation of the urban wastewater management endeavor. MWRI, as the national water authority, has to take the lead in developing and sustaining the cooperation.***

Procedures *Establish a commonly agreed cooperation framework, clarify each party's authority and obligation lines, and establish a financial mechanism to support cooperation in water quality management.*

7. Conclusions

Reuse of municipal wastewater in irrigation is practiced in many parts of the world. Although certain health risks are associated with wastewater irrigation, it can offer potential benefits by reducing pollution in receiving water bodies (mainly agricultural drains in the Egyptian context) and increasing fertilizer and vital nutrients. It is important to have the right policies and implementation procedures in place.

This document identifies critical issues in Egypt's urban wastewater management practices, and presents remedial policies and accompanying procedures recommended by the APRP/MWRI Wastewater Task Group. Table 5 below lists the contents of these recommended policies and procedures.

Table 5. List of Recommended Policies and Procedures

Focused Areas	*Contents of Policies and Procedures*
Wastewater treatment	1. Prioritizing construction of treatment plants at given budget levels. 2. Making existing treatment facilities function. 3. Treating industrial wastewater at the source.
Health concerns and wastewater quality standards	4. Recognizing pathogenic threats on human health in wastewater irrigation. **5. Understanding wastewater quality standards, MHUUC Decree 44/2000, and MOHP role in wastewater quality inspection and regulatory development.**
Reuse of wastewater effluents	**6. Separating untreated sewage from reuse drains.** **7. Encouraging MWRI efforts in drainage monitoring.** **8. Initiating restricted crop irrigation.** **9. Using wastewater effluents to grow timber trees in desert areas.** 10. Using wastewater effluents to grow urban green lands.
Inter-ministry cooperation	**11. Establishing a cooperation framework including division lines of responsibilities and financial mechanisms for cooperation.**

The rationale for the development of these policies is summarized as follows:

- The discharge of a large volume of concentrated urban sewage into agricultural drains is the major threat to water quality in the Delta.

- The two wastewater-mixing processes (mixing with drainage in agricultural drains and mixing with freshwater in canals) disperse the pollution and degrade the water quality of the entire Nile irrigation system in the Delta. A central need for separating or minimizing the entrance of wastewater at these two mixing points remains. This is the fundamental impetus for the development of remedial policies.

- The discharge of wastewater "consumes" more potentially reusable drain water and an alternative to drains as dumping sites is not available in the Delta. Therefore, use of wastewater in the Delta is the most promising means to exhaust the water so that the negative effect on the general irrigation system can be minimized. All suggested optional uses of wastewater, including timber-tree irrigation, should be considered in this respect.

- A priority task in wastewater treatment is to improve the performance of existing wastewater treatment plants. Law 48 and MHUUC Decree 44/2000 provide sufficient guidelines for better wastewater management that should be respected by all involved parties. Inter-ministry cooperation is the foundation of the wastewater management endeavor and MWRI has the obligation to lead, support, and sustain cooperation efforts.