Project Document

Lake Manzala Engineered Wetland

Project: EGY/93/G31
Contract: EGY/93/G31/SUB2

Prepared for:

United Nations Development Agency
One United Nations Plaza
New York, New York
United States 10017

Prepared by:

Tennessee Valley Authority
400 W. Summit Hill Drive
Knoxville, Tennessee 37902

March 31, 1997

UNDP PROJECT DOCUMENT
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UNITED NATIONS DEVELOPMENT PROGRAM (UNDP)
Project of the Government of
Egypt

Project Document
EGY/93/G31/B/lG/99

Number & Title: Global Environmental Facility/Egyptian Engineered Wetlands - Construction of Wetland Project Components
Duration: Five years
Project Site: Port Said & Cairo, Egypt
ACC/UNDP sector & subsector:
0320 Land and Water
1030 Environmental Health / Pollution Control
Government section and subsector:
Environment / Water
Executing Agency: Egyptian Environmental Affairs Agency (EEAA)
Estimated starting date: July 1997
Government inputs: (local currency)
(in kind) 1,980,000 L.E.
(in cash) ____________

UNDP and cost sharing financing	
UNDP	
IPF	$4.0 x 10^6$
Other(specify)	$ ________
Govt. or third-party cost sharing (specify) (109)	$ ________
UNDP & cost sharing (99)	
Total	$4.0 x 10^6$

Brief description:

A major environmental and economic concern in Egypt is the poor quality of the north flowing drainage waters. Presently, only 4 percent of the country is inhabited, primarily because of inadequate fresh water supplies. Much of the heavily polluted drain water crossing the Nile Delta enters large coastal lakes such as Lake Manzala before flowing into the Mediterranean Sea. Water entering the Lake carries pollutants into the Sea which are in violation of international agreements signed by Egypt. Objectives of the project are to: (1) promote sustainable development by enhancing environmental and economic opportunities at the local and national level; and (2) construct and operate a demonstration wetland that will treat 25,000 to 50,000 m^3 per day of wastewater before it enters Lake Manzala. The treatment capacity depends on available funds and site conditions. A capacity of 50,000 m^3 per day is anticipated for a site with 1 meter of ground elevation above the normal subsurface water level. The capacity would be reduced to approximately 25,000 m^3 per day for a site with 0.5 meter of ground elevation. The final capacity will be determined during project design, based on actual site conditions and detail cost estimates.

On behalf of:	Signature	Date	Name/title (please type)
The Government Executing Agency:	____________	________	Egyptian Environmental Affairs Agency (EEAA)
UNDP:	____________	________	Operational Unit for Development Assistance (OUDA)

United Nations' official exchange rate at date of last signature of project document:
$1.00 = 3.34 LE

UNDP PROJECT DOCUMENT

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LIST OF ABBREVIATIONS

BOD	Biological Oxygen Demand
Cd	Cadmium
CEC	Cation Exchange Capacity
cm	Centimeter
COD	Chemical Oxygen Demand
d	Day
EEAA	Egyptian Environmental Affairs Agency
EIA	Environmental Impact Assessment
EMR	Environmental Management Report
Fe	Iron
GADF	General Authority for the Development of Fisheries
GIS	Geographic Information System
GOE	Government of Egypt
GPS	Global Positioning System
GS	Ground Surface
ha	Hectares
Hg	Mercury
HP	Horse Power
kWh	Kilowatt hour
L	Liter
m	Meter
mg	Milligrams
microhoms/cm	Microhoms per centimeter
MOU	Memorandum of Understanding
mm	Millimeter
Mn	Manganese
msl	Mean Sea Level
MSS	Multispectral Scanner
NGO	Nongovernmental Organization
OUDA	Operational Unit for Development Assistance
Pb	Lead
pH	Measure of acidity or alkalinity of a solution
PMC	Project Management Committee
ppb	Parts per billion
ppm	Parts per million
PVC	Polyvinyl chloride pipe
Q	Discharge in m^3/s
QA/QC	Quality Assurance/Quality Control (in laboratory analysis)
RBV	Return Beam Vidicon
SAR	Sodium Adsorption Ratio
T/yr	Tons per year
TFP	Technical Focal Points
TM	Thematic Mapper
TN	Total Nitrogen
TP	Total Phosphorous
TSS	Total Suspended Solids
UN	United Nations
UNDP	United Nations Development Program
VEC(s)	Valued Environmental Component(s)
Zn	Zinc

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SECTION A CONTEXT

A.1 Description of Subsector

A.1.1 Interaction of Lake Manzala and the Mediterranean Sea

Lake Manzala is located on the northeastern edge of the Nile Delta, between Damietta and Port Said (Figures 1 and 2). It is separated from the Mediterranean Sea by a sandy beach ridge which has three open connections between the Lake and the Sea. These open connections allow an exchange of water between the Lake and the Sea. For example, the northern portion of Lake Manzala is characterized by high salinities ranging from 3000 mg/L to 35,000 mg/L, due to the influence of the Mediterranean Sea. Tidal flow measurements for Lake Manzala in 1986 revealed that 6878 x 10^6 m^3 of water flow into the Lake, but 9007 x 10^6 m^3 are returned to the Sea. The net balance flows from the Lake to the Sea and represents a consistent annual input to the Mediterranean Sea. A major land reclamation project and associated irrigation program by the Government of Egypt is expected to increase the level of interaction of the Lake with the Sea by altering the existing flows such that the polluted waters of the Bahr El Baqar drain will have faster and more direct access to the Mediterranean Sea.

A.1.2 Characteristics of Lake Manzala

Lake Manzala is a shallow brackish lake with an area of approximately 1000 km^2. Road banks and islands, zones of dense emergent vegetation, and "hoshas" (illegal fish enclosures) limit water circulation and form basins with very different water and sediment characteristics. The flow of water into Lake Manzala comes from several drains. The Bahr El Baqar drain dominates, both in highest water flow and highest pollutant load. Wind is a key factor in the Lake's circulation. Evaporation during the summer season is an important factor in the Lake’s water balance.

The Lake is exposed to high inputs of pollutants from industrial, domestic, and agricultural sources. Pollution originates in urban centers such as Cairo and also along the lengths of the drains. The most important sources are in eastern Cairo. Untreated and poorly treated wastewater is transported to Lake Manzala by the Bahr El Baqar drain over a distance of 170 km. The drain is heavily polluted and anoxic over its entire length. Methane and hydrogen sulfide bubble up to the surface and release climate gases. Large amounts of particulate matter, nutrients, bacteria, heavy metals, and toxic organics are transported to the Lake via the drain.

Where the anoxic water from the Bahr El Baqar drain enters Lake Manzala, reduced iron is oxidized and precipitated as hydroxide in a zone of gray water between the black drain water and the green Lake water. The oxidized iron precipitates on fish gills, causing tissue damage and mortality. As a result, only the hardiest organisms can tolerate Lake Manzala near the entrance of the Bahr El Baqar drain. Among these species, malformations, discoloration, and stunted growth are common.

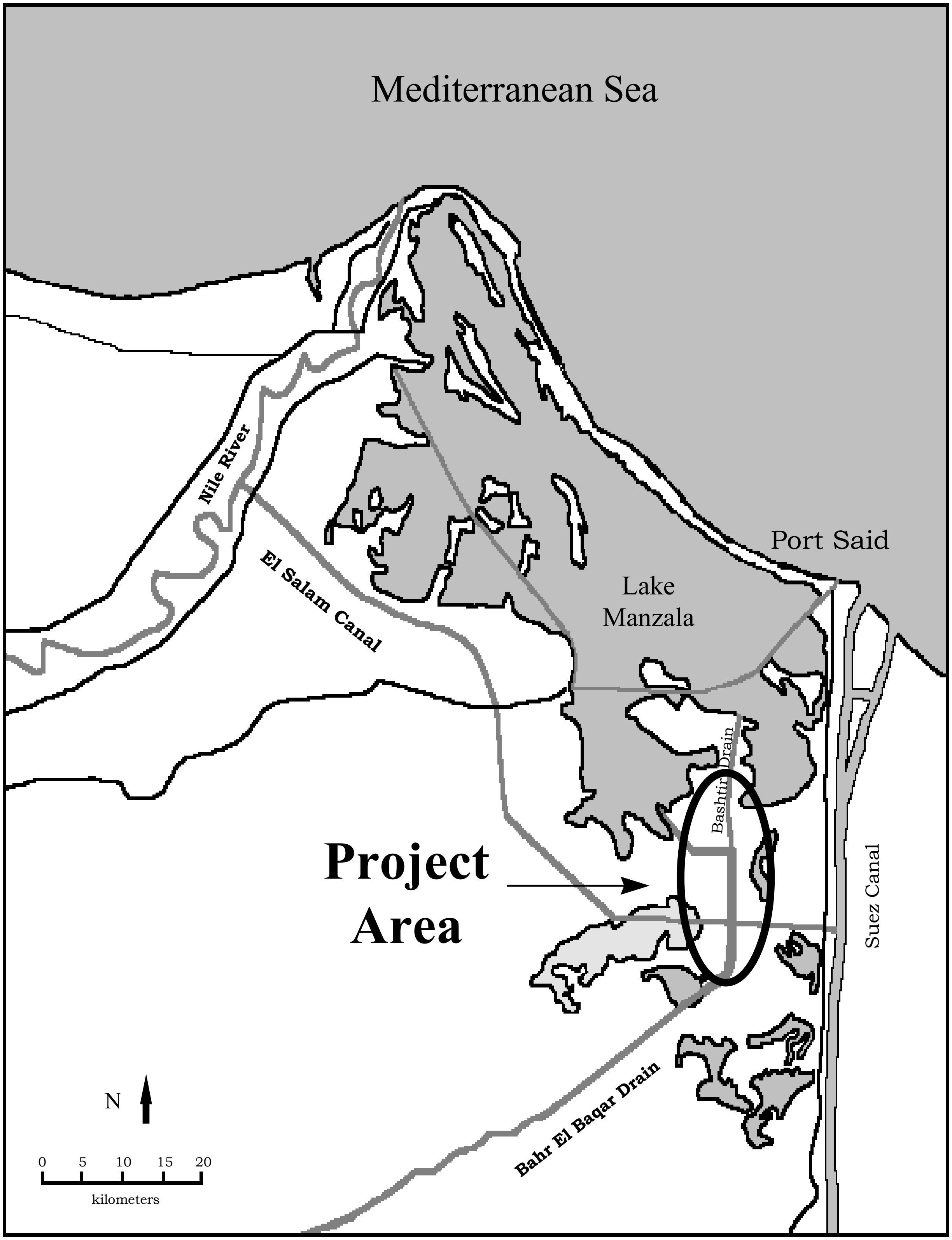


Figure 1. Project Area

page for figure 2

The Lake is highly eutrophic with both macrophytes and planktonic algae contributing to extensive carbon fixation. The nutrient input comes from fresh water inflows such that productivity decreases as salinity increases nearer the Mediterranean Sea. The nutrient input, particularly through the Bahr El Baqar drain, has a relative excess of phosphorous compared to nitrogen. A large proportion of the primary production occurs in macrophytes which constitute a "blind path" in the aquatic food web. Fish production in the Lake is high with a total catch of approximately 45,000 tons. The average catch per hectare (10,000 m^2) is 450 kg with catch amounts in excess of 900 kg/ha in the southeastern portion of the Lake.

Historically, the salinity of Lake Manzala was higher and the nutrient and toxic loads were much lower. The fish catch was smaller; however, and species composition was more varied with highly valued marine species including mullets and sea bass constituting an important portion of the overall catch. Currently, approximately 90 percent of the total catch consists of four species of tilapia with the majority of individual fish less than ten centimeters in length.

Although the southeastern basin area near the Bahr El Baqar drain is the most productive fishing area, only tilapia spp. and catfish survive. Catches are dominated by the smallest and hardiest of the tilapia species, T. zilli. This species shows a high frequency (85 percent) of organ malformation and discoloration, caused by environmental and contaminant stress. Among the Port Said inhabitants, Lake Manzala fish have a reputation for being chemically and microbially contaminated and, thus, unhealthy to eat. The public are afraid to eat fish from a Lake that once provided 30 percent of all Egypt's fish. This has had a severe social and economic impact on Lake residents as well as local and national political repercussions.

The most important local problem is the quality of water in the area. Contaminated drain water is used for washing dishes and vegetables. Drinking water must be transported to the area. Imported water from nearby Port Said and Mataryia is often not suitable for human use. Contaminated drinking water is responsible for enteric diseases such as gastritis, infective hepatitis, amoebic dysentery, *Ascaris* and other parasitic infections, schistosomiasis, and dermatitis.

With regard to biodiversity, there has been a substantial reduction over the last few decades in both fish and bird species. The single most important factor may be the decrease in water salinity, except for the northwestern basin where an embankment has led to a negative water balance, hypersalinity, and loss of species diversity. In the southeast, water pollution and excessive eutrophication have caused the disappearance of many species. In some areas of the Lake, the benthic fauna has been impacted by contaminants from the drain inflows. Extreme fishing pressure and hunting of birds have further reduced biodiversity.

Extensive land reclamation during this century has reduced the Lake surface area to less than half of its original size. The reclamation is progressing at an accelerating pace. The satellite image maps from 1990 showed water in many places where land had subsequently been created and islands enlarged. Most of the lake south of the El Salam Canal has been reclaimed. There are plans for further land reclamation north of the El Salam Canal.

Additional illegal land reclamation and the intensive fishery, partly with illegal methods, are indicative of the increasing human population pressure on Lake Manzala. Even though the area has a low population density by Egyptian standards, the number of inhabitants is increasing rapidly. Much of this colonization is illegal and unauthorized. The living standard, including income, education, and health, is worse than the Egyptian average. There are also conflicts between the new settlers and the established inhabitants. Legally, the status of land claims is often uncertain even after generations of occupancy. Law enforcement is inadequate in regard to land use, illegal fishing, and other human activities.

Other physical, chemical, and biological alterations to the Lake are causing social and economic disruptions. The El Salam Canal, a one billion dollar water diversion project, will take some of the cleaner drain water to the Sinai. It will no longer flow into the Lake. Of the 200,000 feddans that will be irrigated on the Lake side of the Suez Canal, return water will contain increased amounts of agricultural chemicals and nutrients. This project is expected to modify Lake circulation and water quality, in particular, salinity. Associated roads and shoreline alterations will lead to reduced water circulation. Dredging and aquaculture activities within the Lake also contribute to the regional cumulative effects and overall deterioration of the Lake. As the salinity of the Lake is altered, farmers on the islands will find it more difficult to obtain fresh water supplies for livestock.

Although cumulative effects are dramatic and concern is widespread, only a poor scientific database exists for Lake management. No predictive modeling tools exist. There is little agreement on priorities for using the Lake. Clearly, local residents are concerned about the use and quality of Lake Manzala. Politicians at the local and national levels are demanding corrective actions, but scientists and environmental managers lack sufficient tools and data to determine and develop support for effective management actions. Cumulative effects like those to Lake Manzala and the Mediterranean Sea are the single greatest contributor to global deterioration and represent major impediments to achieving sustainable development.

A.1.3 Waste Management Control

Responsibilities for environmental protection in Egypt are dispersed among a number of federal ministries and Governorates. A central focus is provided by the Egyptian Environmental Affairs Agency (EEAA) established in 1982. EEAA has executive powers for inspection and enforcement. In Egypt, pollution control and treatment facilities are generally inadequate. In many cases, pollution occurs unabated. When environmental legislation has been passed, it often lacks realistic guidelines or has inadequate measures for enforcement. All of these factors contribute to the increasing pollution of Lake Manzala and, therefore, of the Mediterranean Sea.

The Egyptian Government has launched an extensive program for construction of wastewater treatment facilities in greater Cairo and other large population centers. Complete coverage of all major sources of industrial and municipal waste, however, is not foreseen in the next 30 years. The new wastewater treatment facilities have concentrated on conventional treatment. The high costs associated with such waste management programs have prolonged implementation of the program. Nutrient and toxic removal by conventional primary and secondary treatment is low (0-30 percent). Even with expensive treatment facilities, the pollution load entering Lake Manzala and the Mediterranean Sea will be substantial. The focus on conventional facilities has limited the use of alternative wastewater treatment systems (such as engineered wetlands) which may be more suitable to Egypt's needs and capabilities. In addition, conventional treatment systems do not address nonpoint sources of pollution such as agricultural inputs.

The national wastewater treatment program and new powers of the EEAA facilitate better monitoring and protection of the water resources in the long term. They do not provide the immediate action required to remedy the serious problems in Lake Manzala and the Mediterranean Sea caused by untreated or poorly treated wastewater. Most of the other cumulative effects are not assessed or managed.

A.2 Host Country Strategy

In 1982, the Egyptian Environmental Affairs Agency (EEAA) was established under Presidential Decree No. 631 of 1982. The Agency is attached to the Presidency of the Council of Ministers and is responsible for preparing Egypt's policy on the management of the environment. Initially, the EEAA focused on the accumulation of scientific and technical data needed for the formulation of the country's National Environmental Action Plan, which was released in March 1992. The National Environmental Action Plan identified Lake Manzala as an alarming example of water pollution in Egypt. This environment has been termed a "black spot" by the Government of Egypt.

During the last two decades, Egypt paid increasing attention to environmental issues at both the national and international levels. Egypt was among the first countries to call for environmental protection at the international level and joined, at its inception, the United Nations Environment Program (UNEP). It is a party to a number of international agreements, including the:

- Convention Relative to the Preservation of Fauna and Flora in their Natural State.
- African Convention on the Conservation of Nature and Natural Resources.
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora.
- Convention for the Protection of the Mediterranean Sea against Pollution.
- Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources.
- Protocol Concerning Mediterranean Specially Protected Areas.
- Convention on the Conservation of Migratory Species of Wild Animals.
- United Nations Convention on the Law of the Sea.
- Framework Convention on Climate Change.
- Convention on Biological Diversity.
- World Charter and Agenda 21.

Internationally, Egypt has been an active participant in the UNEP sponsored and coordinated Mediterranean Action Plan and since 1978, has been a contracting part to the Convention for the Protection of the Mediterranean Sea Against Pollution. The country requires assistance, however, if it is going to fully comply and participate in these international efforts.

In 1991, Egypt signed a protocol to host the Regional Center for Environment and Development for the Arab Region and Europe, funded jointly by the United Nations and countries within the region. This autonomous body assists in developing programs and policies to resolve environmental problems in the region.

Relevant national legislation in force in Egypt includes the:

- Law No. 48 (1982) for the Protection of the River Nile and Water Channels.

- Minister of Industry's Decree No. 380 (1982).

- Law No. 102 (1983) for Natural Reserves and Conservation of Nature.

- Law No. 124 (1983) for Fishing, Aquatics, and Regulating Fish Farms.

- Law No. 12 (1984) for Drainage and Irrigation.

Additionally, the National Environmental Action Plan is intended to deal with the environmental problems that will be confronting Egypt in the short, medium and long terms. In order to strengthen the environmental structure and management process of the country, the Egyptian parliament is considering a new environmental law to provide greater cooperation and coordination among government ministries and agencies. It also gives the EEAA increased powers and duties for inspection, enforcement, and environmental assessment.

A.3 Prior or Ongoing Assistance

A variety of international agencies have given support to various initiatives developed by the Government of Egypt to overcome serious environmental problems. Those projects related to the development of an engineered wetland treatment facility in Lake Manzala include:

- The Fariskur Waste Management Pilot Project by USAID, conducted to evaluate appropriate waste treatment technologies for use in small local communities.

- The Greater Cairo Wastewater Project which involves the construction of an extensive sewerage network and six major treatment plants with assistance from the Arab Fund for Economic and Social Development, designed to reduce industrial and municipal pollution levels emanating from the Egyptian capital.

- The Canal Cities Water and Wastewater Project to review wastewater treatment effluent and sludge disposal alternatives for the cities of Suez, Ismalia, and Port Said, funded by USAID.

Several institutes are conducting related studies, including:

- The pilot rock-reed wetland at Ismalia operated by the Suez Canal University in collaboration with Portsmouth Polytechnic in the UK, and a study located at the Tenth of Ramadar.

- The Water Hyacinth Institute, which is working on the commercialization of water hyacinth products. The engineered wetland provides an opportunity to turn bench scale results into commercial successes.

- The Drainage Research Institute of the Water Research Center, which has studies and ongoing monitoring programs related to the main drains such as Bahr El Baqar. The wetlands project technology has potential application to other water pollution problems of concern to scientists at the Water Research Center.

- The Central Laboratory for Fish Research at Abassa and the Institute of Oceanography at Alexandria have scientific studies underway on the Lake.

A.4 Institutional Framework

In 1991, a national conference on Lake Manzala Environment was held in Port Said. One of the outcomes of this conference was a Supreme Committee for the Rehabilitation of Lake Manzala to ensure coordination among various authorities and agencies, to improve Lake management, and to protect the Lake environment. The Supreme Committee lacks substantial authority to make changes and does not have the budget necessary to conduct the scientific studies. The Supreme Committee, however, is a useful forerunner of a more permanent authority for managing the Lake. It brings together many of the key governmental agencies. At present, the prime legal authority for the Lake resides with the General Fish Authority within the Ministry of Agriculture.

No single line ministry of the Egyptian Government has the requisite expertise to address and manage this type of project. The Ministry of Agriculture promotes land reclamation for increased agricultural production at the expense of Lake Manzala. The Ministry of Public Works and Water Resources has centered upon the reuse of all appropriate water for irrigation and agricultural development at the expense of Lake Manzala.

Because of the inexperience of Egypt's ministries in large interdisciplinary projects and the lack of anyone with a broad enough mandate in regard to the project, the EEAA will be the Executing Agency. EEAA has the legal authority to coordinate among ministries for problems relating to the environment. It also has the authority by law to execute pilot projects and new approaches to environmental protection and management. EEAA is attached directly to the Cabinet of Ministers which facilitates communication and implementation. EEAA also has a lead role in all similar environmental rehabilitation projects in the country and has right-of-access to information from all other ministries.

Other areas of government that are involved in jurisdictional issues related to the range of interdisciplinary topics this project involves include: the Governorate of Port Said, the General Fish Authority (Ministry of Agriculture), the Ministry of Agriculture, the Ministry of Public

Works and Water Resources, the Ministry of Housing and Reconstruction (Potable Water and Sewage Authority), the Ministry of Health, and various scientific institutions including the Central Laboratory for Aquaculture at Abassa, the Water Research Center and its related institutes, the National Research Council Laboratory, Suez Canal University, the National Institute of Oceanography and Fisheries at Alexandria, and the Water Hyacinth Institute at Zagazig University.

SECTION B PROJECT JUSTIFICATION

B.1 Problems to be Addressed and Present Situation

Deteriorating water quality is the major impediment to development in Egypt. The problem to be addressed by this project is how to achieve sustainable development for the people living in the Lake Manzala area (and in particular, the residents of the Bahr El Baqar drain area) while improving water quality and the Lake environment. This is one of the most poorly serviced areas in Egypt. Local residents do not have access to what would be considered the minimum requisites for life. Deteriorating water quality and fish stocks with the concurrent human and ecosystem health risks are major problems. Many people live as squatters precariously on Government land and lack the security of land ownership and economic stability. The environmental deterioration is detailed in Section A.

The proposed project demonstrates one approach to achieving sustainable development. During the five-year project period, an engineered wetland will be constructed to improve water quality, aquatic habitat, biodiversity, and reduce climatic gases. The project will increase social and economic sustainability through local cooperatives, empowerment of local residents, Nongovernmental Organizations (NGO) activities, training, and national capacity building to achieve Egyptian self-sufficiency in this form of biotechnology. The engineered wetland will produce 25,000 to 50,000 m^3 of clean water per day, depending on site conditions. Biomass will be harvested and processed into marketable products. The clean effluent water will be used for an aquaculture facility that will provide juvenile fish for restocking the Lake and for other aquaculture ventures.

B.2 Expected Project Benefits

The expected benefits from construction and operation of the engineered wetland at the northern portion of the Bahr El Baqar drain are as follows:

- The wetland will demonstrate a sustainable low cost alternative to traditional waste treatment in Egypt and a national self-sufficiency to implement this technology throughout the country.

- Institutional strengthening will occur at the local, and national level through the cooperative efforts required to plan and manage the wetland, and to market wetland by-products.

- The quality of life for the local participants will improve as the wetland generates employment, reduces the risk of disease from contaminated water and fish, and improves local fisheries.

- The local participants will be assisted in operating the aquaculture facility, and in harvesting and marketing biomass products, such as fuel pellets and animal feed.

- An integrated environmental monitoring and information program will be implemented to record, compile, and assess the wetland operating efficiency, including pollution reduction, biophysical changes, and socioeconomic improvements.

- The level of pollutants flowing into Lake Manzala and the Mediterranean Sea will decrease.

- The improved quality of water entering the Lake through the Bahr El Baqar drain will promote biodiversity and enhance habitats for fish and bird species that are unable to survive in the present aquatic ecosystem.

- The production of greenhouse gases from the polluted Bahr El Baqar drain flowing into Lake Manzala will be reduced and the generation of oxygen will increase.

At the end of the five year project, there will be a fully operational, engineered wetland treating 25,000 to 50,000 m^3 per day of highly-polluted drain water. There will be a biomass harvesting and aquaculture facility operated by local employees and assisted by NGOs. The project will provide an example of sustainable development in practice, with improvements in both the local economy and the environment.

With extrapolation and wider use of this technology by local residents, both Lake Manzala and the Mediterranean Sea will have improved water and sediment quality as inflow contaminants are reduced. There will be enhanced fish habitats, healthier fish, more fish and bird biodiversity, and a reduction in climate gases of the anoxic drain water. The health of the local population will be improved with the enhanced environmental quality.

The project team, governmental technical focal points, and selected graduate students will be familiar with the biotechnology and will be able to lead Egypt's efforts in wetland self-sufficiency. The project team will compile economic and monitoring data on the effectiveness of the wetland and aquaculture systems over a range of conditions. Information will be obtained concerning wetland function, operation, and transferability to other sites in Egypt.

The potential for this technology exceeds the 25,000 to 50,000 m^3/d of drain water to be treated. There can be little successful development in Egypt without a safe and affordable water supply. Waste management, as in many other developing countries, has concentrated on costly conventional treatment facilities that often do not provide the level of treatment needed. The costs involved with the long-term management of wetland treatment facilities are within Egypt's capability and will provide an incentive to extend the process to other highly polluted areas.

EEAA will have an enhanced role and reputation as a leader in the provision and protection of environmental quality in Egypt. EEAA will gain institutional strength in project delivery and implementation that can be transferred to other Egyptian problem areas.

By the end of the project, the engineered wetland will be fully operational. There will be a wetland authority that will be responsible for the facility. The institutional arrangements for long-term operation of the facility will be determined before the project ends. At the end of the project, much of the routine operations and maintenance will be conducted by the local employees who are selling biomass and fish products. There will be a continuing need for the Government of Egypt to provide the electricity to the facility and oversight management and monitoring.

B.3 Target Beneficiaries

The beneficiaries of the project will include:

- Local residents and in particular, those that are involved in operating the wetland for biomass products and aquaculture.

- Local residents who will be employees in the construction and operation of the wetland.

- Local fishermen who adopt improved fish farming techniques demonstrated by the aquaculture facility.

- NGOs that participate in the wetland demonstration and focus on the project area and its development. This will enhance the benefits of the project to the local economy and improve the NGOs' ability to deliver programs in the area.

- All residents regardless of economic category because of the enhanced environmental awareness and emphasis on the health risk associated with water pollution.

- Regional scientific institutions and individual scientists that use the wetland facility for research studies and training.

- The Governorate of Port Said.

- National governmental bodies, and in particular, the EEAA.

- The country of Egypt in its standing internationally on environmental protection and rehabilitation.

The project will demonstrate how to improve the quality of the environment as well as the quality of life of the people in the Bahr El Baqar area. New employment, new skills, new businesses, and higher incomes will lead to an improved standard of living including better health and educational opportunities. Approximately ten new jobs will be created in the operation and maintenance of the wetland. Fewer chronic diseases and healthier food intake are expected to result from broader application of the wastewater treatment and aquacultural techniques demonstrated by the engineered wetlands.

Environmental awareness will develop among the local population as the project attracts the attention of the people to environmental issues such as the pollution of the Lake and drains. Through success of the project, knowledge will be passed on to a wider group of beneficiaries within the watershed, the Egyptian Government, research organizations, and other environmental agencies and interest groups.

Adoption of the wetland systems will benefit other Mediterranean countries by reducing international water pollution. The project can have far-reaching effects by demonstrating a cost-effective alternative to conventional wastewater treatment in reducing contaminant loadings to international waters.

Species diversity of several major groups of animals such as birds, fish and lower trophic dwellers will ultimately increase through habitat enhancement. Many aquatic wildlife species, a number of which have seriously declined, will benefit by improved wastewater treatment. Aquatic plants and animals will benefit from wider adoption engineered wetlands.

B.4 Project Strategy and Implementation Arrangements

The predominant feature of the project is that it will be Egyptian executed with the EEAA taking overall responsibility for the project. EEAA will act as the conduit for project communications between the UNDP and the Government of Egypt. The overall project organization appears in Figure 3.

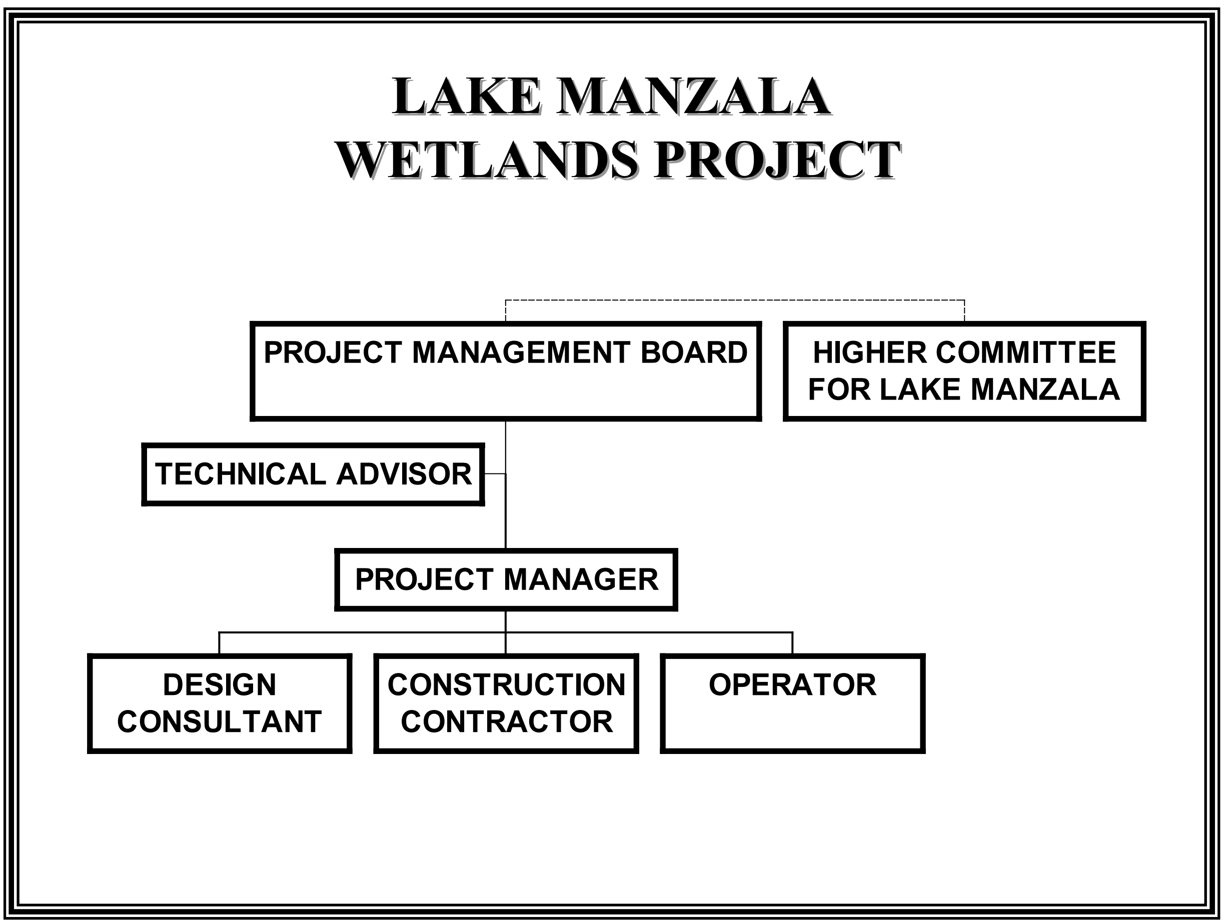
The Engineered Wetlands Project centers on protecting of the global environment. Inherent to the project is a set of diverse interdisciplinary needs. No single line ministry has the expertise to address and manage this type of interdisciplinary project. In some cases, the mandate of a line ministry is in conflict with the project. For example, the Ministry of Agriculture promotes land reclamation for increased agricultural production at the expense of impacting Lake Manzala. The Ministry of Public Works and Water Resources focuses on the reuse of water for irrigation and agricultural development, also impacting Lake Manzala. Neither ministry has significant direct experience in large interdisciplinary projects. These ministries are invaluable, however, for the expertise and resources they can contribute to the project.

In addition, because many ministries are potentially involved, no one has a clear mandate and set of functions to manage the others. After much consideration and discussion with the line ministries, the EEAA appears to be the most suitable Executing Agency. The primary EEAA mandate centers on protection of the environment and rehabilitation of the so called "environmental black spots," including Lake Manzala which is prominently featured in the recent National Environmental Action Plan and in the formulation of the Supreme Committee for the Rehabilitation of Lake Manzala.

In addition to a mandate commensurate with the project objectives, EEAA has a number of advantages as an Executing Agency. First, by law, EEAA has the authority to coordinate among ministries for environmental problems. Second, it has the legal authority to execute pilot projects. Third, it is attached directly to the Cabinet of Ministers which facilitates short circuiting of bureaucratic layers. The Minister for Cabinet Affairs also chairs EEAA. Fourth, it has a lead role in all similar environmental rehabilitation projects in the country. Fifth, according to law, it has access to all information from all other ministries; no line ministry has this authority. Sixth, although EEAA is short staffed, the priority given to the project to date and the

Figure 3

Organizational Chart
Egyptian Wetlands Project



competency and efficiency which the EEAA staff devoted to the Feasibility and Pre-implementation Phases, establishes a successful track record in regard to project management.

In addition, the Agency is presently undergoing considerable strengthening. Agency personnel have rapport with other ministries and were effective in coordinating the Feasibility Study. EEAA can successfully execute the project given that a strong Project Manager is appointed with the requisite array of national and international experts, the adequate support of the Government of Egypt, and the timely acquisition of permits and approvals. Much of the construction of the wetlands will be conducted by specialized private contractors hired locally. This is the standard operating procedure for line ministries implementing physical works.

The Project Management Board (PMB) will consist of representatives of concerned agencies with relevant decision-making authority. It will be headed by EEAA as represented by the Head of Water and Coastal Area Protection Projects. The Project Manager will serve as the Rapporteur of the PMB. The roles of the PMB are to oversee project operation and accountability, which will be enforced by the Executing Agency; to facilitate interagency coordination; and to ensure that the project commitments of the Government of Egypt are met in a timely manner. The PMB will also review project reports prepared by the Project Manager before submission to the UNDP.

The PMB will consist of senior level personnel designated by the heads of their respective agencies who would have authority to ensure that the actions needed from the Government of Egypt will be undertaken effectively. The membership of the PMB overlap with that of the Supreme Committee for the Rehabilitation of Lake Manzala so as to enhance the expertise and understanding of the overall problems and management solutions for the Lake.

The PMB will regularly review project performance relative to project objectives. The PMB will assist the Project Manager, but also offer critical comment, recommend additional actions, and modify plans as necessary to facilitate project implementation. Each member of the PSC will designate one or more Technical Focal Points from their ministry to serve as resource persons for the Project Manager.

The PMB will be comprised of representatives from the:

- Governorate of Port Said
- General Authority for Development of Fisheries
- Egyptian Environmental Affairs Agency
- Local Fisherman NGO
- Ministry of Agriculture
- Ministry of Public Works and Water Resources
- National Organization for Potable Water and Sanitary Drainage
- Suez Canal University
- United Nations Development Program

B.5 Reasons for External Assistance

The Government of Egypt's commitment to environmental protection has been demonstrated by various actions in recent years, including the formulation of the National Environmental Action Plan to identify and address the most alarming examples of water pollution in the country. The passage of the new environment legislation also strengthens environmental regulations and the EEAA.

Without a demonstration project to prove the benefits of the low cost engineered wetland treatment, large quantities of pollutants will continue to contaminate the Nile River drainage system, Lake Manzala, and the Mediterranean Sea. The costs of wetland treatment facilities are well within the national capability of the Government of Egypt. The low cost and potential income from aquacultural operations will provide an incentive for extending wetland biotechnology to other highly polluted areas. It is anticipated that the engineered wetland will constitute a key rehabilitation measure under the country's National Environmental Action Plan. The project will create an international visibility for wetland systems as a proven technology, making the activities more relevant in Egypt, as well as internationally.

B.6 Special Considerations

Environmental neglect in Egypt has resulted in serious "black spots" such as Lake Manzala. The political will is present to address these problems with appropriate technical assistance and financial resources.

B.6.1 Poverty Alleviation

The project area is occupied by poor and lower middle class families. Most earn a living by fishing in the Lake using traditional methods. Gross earnings are limited by the daily catch and prices offered by middlemen. Prices are usually low. Only one or two persons in the family are employed full time. One of the primary objectives of the project will be to employ local inhabitants in the construction and operation of the wetland.

The project will produce substantial employment opportunities for unskilled and skilled local workers. Jobs will include excavation, construction, road building, and transportation during the construction phase. Additional work will be associated with harvesting and planting seedlings within the wetlands. In subsequent phases, the project will generate jobs related to the maintenance of the wetland system, monitoring, aquaculture facility, biomass harvesting, and sludge dredging.

The biomass harvested from the wetland system will be used as compost and animal feed. Currently there are about 27,000 cows and buffaloes in the region. Expanded use of wetlands can provide a cheap source of high-protein animal feed that will aid animal production and increase local incomes. Biomass might also be used to manufacture fuel pellets for domestic and industrial uses. Brood stock from the aquaculture operation can be made available to fish farmers to enhance fish productivity and annual catches.

B.6.2 Participatory Activities

The project will increase local awareness of environmental pollution, health risks from contaminated food and water, personal hygiene, and maintenance of sanitary conditions. The project has attracted favorable attention among the local population through public meetings and the media. This publicity has generated a positive attitude toward reducing environmental pollution. Construction and operation are designed to maximize participation by local residents. The wetland will offer opportunities for the local residents to participate in operation and maintenance, impact monitoring, biomass utilization, and utilization of brood stock from the wetland fishery.

One of the advantages of engineered wetland treatment systems (as compared to conventional treatment systems) is creation of support services and small scale manufacturing ventures. Possibilities include plant harvesting and propagation of seedlings for stocking the wetland, production of fill material from the sedimentation basin, fuel and animal feed pellets from the harvested biomass, harvesting of aquatic plants from the wetlands. Once the project reaches operation, private sector participation will be used to demonstrate the economic potential of the wetland and aquaculture facility.

B.6.3 Gender Issue

Although there are inherent restrictions to the emancipation of women in terms of education, employment, and social participation, the project will generate opportunities for cottage industries and economic ventures that will offer employment opportunities for women.

B.6.4 NGOs

Strong NGO support will be needed to fully realize all of the potential benefits of the demonstration wetland. NGOs will participate in the formation and operation of the biomass harvesting and aquaculture operations. NGOs will also assist in operating and monitoring the wetland facilities. NGO financial support will be obtained to assist in performance monitoring, training, and technology transfer activities.

B.7 Coordination Arrangements

The engineered wetland project relates to the mandates and ongoing activities of several ministries and governmental agencies. Much of the coordination and sharing of information will be accomplished through the Project Management Board and the Technical Focal Points. The EEAA will serve as a coordinating liaison working with the Project Manager. The project organization chart (Figure 3) illustrates interrelationships. Additional ad hoc committees may be established by the Project Manager as needed. The coordination role of the EEAA is expected to strengthen EEAA's capabilities as an Executing Agency and help translate the Lake Manzala experience into practical results in other parts of the country.

B.8 Counterpart Support Capacity

From the initial project identification mission, the Government of Egypt (GOE) has supported the project and endeavored to ensure success. The GOE and EEAA have made personnel and facilities available and served as a liaison with other federal agencies and the Governorate of Port Said. They have working relationships that are crucial to implementation of the project.

This support was evident in obtaining agreement on the transfer of title for the original project site, although alternative sites are now being considered. Securing the title to a suitable project site will be a prior obligation to project approval.

In addition to environmental initiatives such as the National Environmental Action Plan and the environmental legislation, EEAA has shown leadership in political support for addressing the broader problem of deterioration in Lake Manzala and its watershed. Agency personnel have focused attention on a comprehensive regional approach to managing water quality in the Lake.

The Government of Egypt is committed to supporting the project through the next five years by providing a project site and government personnel from EEAA, other federal units, and the Governorate of Port Said. At the end of the five-year project, the GOE will ensure that suitable arrangements are established for long-term operation of the facility. The GOE will also promote technology transfer and broader adoption of the wetland and aquaculture systems.

SECTION C DEVELOPMENT OBJECTIVES

The overall objective of the project is to improve the global environment and national to global environment linkages by reducing international water pollution. This will be accomplished by: (1) promoting sustainable development through enhanced environmental and economic opportunities at the local and national levels; and (2) demonstrating engineered wetland technology as a low cost and efficient method for treating large bodies of water in Egypt (thus addressing serious impediments to national and regional development, namely, poor water quality and low incomes).

First, this project will demonstrate cost-effective methods for improving the quality of water entering Lake Manzala and the Mediterranean Sea, thus contributing to the protection of an international body of water of considerable importance. The project will facilitate the transfer of a low cost biotechnology to a developing country. Engineered wetlands provide an economically and environmentally sound alternative to traditional wastewater treatment facilities. A local hiring policy and a technical assistance program will facilitate successful operation of the wetlands and transfer of the technology to other parts of the country.

Second, the major impediment to national development is the lack of a clean water supply. This project constitutes a sustainable development methodology that can provide Egypt with a greatly enhanced development potential. Achieving the second development objective will ensure that the environmental and economic benefits of sustainable development are fully realized. Many benefits are expected as a result of cleaner water. These include job opportunities for local residents, small scale industries that utilize biomass by-products; opportunities for the women in the local community; support and reinforcement of regional efforts to manage the resources of Lake Manzala and the coastal Mediterranean area; an improved fishery in Lake Manzala; decreased health risk associated with consumption of Lake Manzala fish; and decreased health risk associated with contact with the water from Lake Manzala.

SECTION D IMMEDIATE OBJECTIVES, OUTPUTS, AND ACTIVITIES

D.1 Immediate Objective 1:

Capacity building for sustainable development in managing Lake Manzala, including local and national participation.

Output 1.1 Strengthen and promote community involvement in environmental management activities.

Activity 1.1.1 Assist local residents in becoming full partners in development and operation of the wetland by implementing an appropriate social, economic, and NGO support framework. The Bahr El Baqar area is almost devoid of services (health care, water, roads, public transport, electricity, education). There are no NGOs working in the immediate project area, and few are close to the project. Local residents do not expect much support from the government. In addition, the lack of sensitivity to local needs in the building of the E1 Salam Canal resulted in considerable suspicion of the governorate and federal authorities.

Early in the project, the Project Manager will confer with local residents and NGOs to identify those interested in participating in the project. NGOs and local representatives will help organize the entrepreneurial activities associated with planting and harvesting biomass and developing the wetland and aquaculture facilities.

Activity 1.1.2 Involve local residents in focusing project objectives on human resource and economic development in the project area. During the preconstruction phase, the Project Management Team will meet with the local fishermen, farmers, and other local residents to discuss socioeconomic needs. During the construction and operational phases, local residents will provide input on employment opportunities, environmental improvements, and operational techniques that should be included in the facility. A working partnership will be maintained throughout the project to promote practical design, operation, and long-term acceptance of the demonstration technologies.

Activity 1.1.3 Increase environmental awareness in the local community and Governorate of Port Said. The Project Manager will work with the local media to develop a program of interactive education. Environmental management principles and practice will be conveyed and discussed. The public will be encouraged to participate and suggest how the local community can benefit from the project.

Activity 1.1.4 Assist local participants in business development. Wetland treatment technology will generate a resource-base for sustainable development. Commercial operations will be developed from the aquaculture facilities and biomass produced by the engineered wetland.

The Project Manager will assist local participants in generating income from construction activities, marketing biomass products, and operating the aquaculture facility. Examples of potential biomass products include: animal feed, building materials, and fuel pellets. There are, however, other products that can be manufactured from water hyacinths, bamboo, papyrus, or other plants that may be grown on site. For example, the Water Hyacinth Institute in Egypt has identified and is developing 18 commercial uses for the plant biomass.

Activity 1.1.5 Identify local construction and maintenance personnel for building and operating the engineered wetland. Local residents will be involved in construction and operation of the engineered wetland. In order to promote the use of local personnel and labor intensive construction techniques, the Project Manager will develop specific guidelines to be followed by the construction contractor. The guidelines will be explicitly incorporated into the design and specifications for the project.

Output 1.2 Capacity building and human resource development to ensure that the engineered wetland can be operated and replicated on a regional scale.

Activity 1.2.1 Identify the government and academic/research organizations and personnel that will participate in the project and establish communication. There are several ways that governmental departments and research institutions will be involved in the project, for example, through membership on the Project Management Board, as Technical Focal Points, and through direct participation in monitoring and operational studies. Proper participation will help ensure that the project becomes a sustainable development model for Egypt and other countries in the region. This will also provide future Egyptian wetland facilities with the national expertise to undertake the work without having to import scientific assistance from other countries.

The Project Manager and EEAA will identify personnel of various agencies and NGOs that will participate in the oversight, review, and monitoring studies. Relevant agencies may nominate these individuals. Roles will be clearly defined to ensure a smooth transition to long-term operation and management. The national engineers, technicians, scientists, and managers will become familiar with the basic concepts, scientific and technical principles, operation and maintenance requirements of the wetland technology, as well as the administrative and socioeconomic facets.

Output 1.3 Disseminate lessons and experiences of wetlands project at global, national, and community levels.

Activity 1.3.1 Prepare and distribute annual reports by the Project Manager to all interested local and national parties. The wetland at Lake Manzala is expected to demonstrate the feasibility of wetland technology under Egyptian conditions. The Project Management Board will ensure that the Egyptian Government is monitoring the progress of the project through EEAA and other line agencies which are mandated to oversee the country's water resources, fisheries, agriculture, and environment. The annual reports will document project results, including costs, performance, operations, local benefits, income, problems, and solutions. The reports will be distributed to all relevant government departments, research institutions, and the donor agencies. National distribution will ensure that the country's planners are aware of the technology and its potential for treating agricultural, municipal, and industrial wastewaters.

Activity 1.3.2 Prepare and distribute scientific papers and reports to interested wetland scientists and institutions through both the primary and secondary literature. When the system is in full operation, detailed scientific reports and papers will be published for distribution among national and international agencies, journals, and wetland scientists. These will elicit scientific and technical responses from similar operations around the world. Donor agencies will be encouraged to use the scientific results in implementing similar projects in other countries.

Other international wetland operations wishing to exchange data and experiences will be encouraged to do so through the Project Manager. The technical reports will be made available to other countries in the region.

Activity 1.3.3 Prepare and distribute socioeconomic results. The project will also generate socioeconomic information related to the improvement of rural water quality, enhancement of human environmental links, development of biomass-based businesses, and the impact on rural families. The information will have immediate relevance to other rural communities in Egypt. The media will be given access to the data and project personnel for developing documentaries and news reports for local and national distribution.

D.2 Immediate Objective 2

Demonstration of engineered wetland technology as a low-cost and efficient method of treating large bodies of water in Egypt and promoting a cleaner Mediterranean Sea.

Output 2.1 Successfully complete preconstruction work for a demonstration scale wetland to treat wastewater.

Activity 2.1.1 Select project team and initiate preconstruction activities. The project will be managed by a national Project Manager. Support staff will include a Senior Project Engineer, Secretary, and Technical Assistant. Detailed terms of reference for the Project Manager and Senior Project Engineer are provided in Annex VI. The Project Manager will be a senior professional with experience in developing and managing large contracts, supervising a large number of technical and professional people, and working with international agencies. The Project Manager will solicit proposals and coordinate the selection of a Design and Construction Supervision Contractor.

Activity 2.1.2 Prepare detailed design drawings and specifications. The Project Manager will be assisted by Egyptian Design and Construction Contractors. During the preconstruction and construction phases, the Design Contractor will prepare civil, electrical, and mechanical drawings and specifications for tendering; evaluate tenders; award contracts and subcontracts; supervise construction; and ensure that contractors adhere to the plans and specifications.

Activity 2.1.3 Establish project offices and laboratory facilities. A project office will be established in Cairo with an office space to accommodate the Project Manager and the office secretarial and support staff. The line of communications between the Project Manager and the Egyptian Government departments and research institutions will be established with the assistance of the EEAA. In addition to the main project office, an office-laboratory-storage facility will be constructed at the project site. The Project Manager will be based in Cairo to maintain a liaison among government agencies, to ensure interagency cooperation, and to obtain permits and approvals. The Senior Project Engineer will be based at the project site and Port Said to oversee site and socioeconomic activities.

Activity 2.1.4 Tender the international contract. An International Consultant will provide technical assistance for the project. A single contract will cover all international expertise requirements for the construction and operation phases of the project. The contract will cover a five-year period and will include an International Coordinator, International Wetland Designer, International Wetland Advisor, and International Field Manager.

The International Coordinator will head the international team. This will be a senior scientist with expertise in project management of large interdisciplinary projects, a Ph.D. in engineering, limnology or a related discipline, and management experience (both theoretical and practical) of large watersheds. The International Wetland Designer and the International Wetland Advisor share responsibilities to ensure availability continuously throughout the project. Terms of Reference and other conditions for the International Consultant are given in Annex VII.

Activity 2.1.5 Undertake necessary field surveys. Ground, soil, and hydrogeology surveys will be completed to delineate the site topography, soil characteristics, and the water table elevations. Soil samples will be obtained from the site area from various depths but within the zone of excavation and analyzed for standard soil parameters such as cation exchange capacity (CEC), size distribution, clay, slit and sand content, organic matter, sodium adsorption ratio (SAR) and permeability. Topographic surveys will help to align the system within the allotted area and will provide data for optimizing the excavation and compaction work. Hydrogeology data collection will provide the data on water table elevation, hydraulic gradients, and hydraulic conductivities.

Activity 2.1.6 Collect hydrometric and water quality data from Bahr El Baqar drain and the Bashtir Canal. These data will include: depth, flow velocity, base sediment load, suspended sediment load, and the water quality parameters. The data will be analyzed by the Project Manager and the Design Contractor to finalize the design and tender specifications. The data will also be used by the international experts to incorporate any changes in the conceptual design.

Activity 2.1.7 Prepare and award tenders. All tenders will be prepared in accordance with the construction regulations and codes of good engineering practice in Egypt. The tender documents will be released for bidding. Documents received from the tendering firms will be evaluated and processed for awarding the primary and subsidiary contracts. Various deadlines and time schedules will be determined for compliance of contracting and subcontracting firms as well as environmental management guidelines to ensure that there is as little environmental disruption as possible during construction.

Activity 2.1.8 Prepare scientific study and monitoring workplan. Protocols and schedules will be prepared to assess wetland operations and monitor treatment performance. Protocols will be established for measuring water quality and ecological parameters. Analytical laboratories will be identified and contracted on an annual basis. All routine, low technology parameters will be analyzed on site. This will ensure consistency in measurement and a cost savings. Graduate students will use the on-site laboratory facilities for research studies. More specialized analyses, such as heavy metals and organics, will be contracted. Procedures and schedules for the QA/QC work will be developed by the Project Manager. The monitoring program is discussed in Annex V.

Output 2.2 Construct a 120 feddan demonstration wetland treatment system consisting of sedimentation pond, engineered wetlands, and aquaculture facility. The system will be capable of treating 25,000 to 50,000 cubic meters per day.

Activity 2.2.1 Order hardware. All hardware required for the wetland system will be purchased ahead of the construction phase so that any delays by the manufacturer in the delivery of the items will not hold up construction and operation. Hardware will include: pumps, the pump intake structures, piping, valves, couplers, gates, and culverts.

Activity 2.2.2 Install water intake and pumping station. The intake will be installed so that the intake water is representative of the Bahr El Baqar drain. An intake manifold will be constructed to limit the uptake of bottom sediment. This will reduce the sediment load into the sedimentation pond and the dredging frequency. Intake pumps will run on electric power. The project will install site transmission lines and tap power from existing lines provided to the site by the GOE.

Activity 2.2.3 Construct sedimentation pond, wetland channels, aquaculture, facility, drying beds, plant propagation facility, and office/laboratory complex. After the tendering process is complete, the selected contractor will construct the engineered wetland. Labor intensive construction techniques will be used to maximize local employment of unskilled workers. Conceptual design and preliminary cost estimates are given in Annex IV. These will serve as a starting point for detailed design. Modifications will be made as necessary to accommodate sound engineering practices and site conditions.

Construction will be supervised by the Design Contractor in consultation with the Project Manager. The Senior Project Engineer will serve as the on-site contact throughout the construction period and will serve as the on-site manager as needed during construction. The International Wetland Designer and International Wetland Advisor will be available for assistance as requested by the Project Manager.

Activity 2.2.4 Conduct plant propagation operation. The engineered wetlands will require a large supply of wetland plants such as cattail, bulrush, phragmites, duckweed, chara, and water hyacinth. These must be available as soon as the civil construction is completed so that there is little delay in the planting and operation of the system. Local plants and harvesting by residents will be used whenever possible. If necessary, a plant propagation facility will be established at the project site and will employ local residents for building the facility, developing seed beds, and tending the seedlings.

Activity 2.2.5 Ensure the participation of the local residents during the construction phase. The participation of the local residents in all aspects of the project before and during the construction will be emphasized whenever skilled and unskilled labor are hired. The project will involve the local residents from the inception of the project to the end of project period, so that the local population will develop a growing affiliation with the project and begin to assume ownership through the activities of the cooperatives, as well as direct project functions. This will facilitate the transfer of technology and socioeconomic benefits to the families and individuals of the area. The Project Manager through the Senior Project Engineer will be responsible for fostering this participation.

Output 2.3 Implement an innovative wetland technology to treat 25,000 to 50,000 cubic meters of polluted water per day, provide a viable basis for sustainable development, and create opportunities for socioeconomic growth in an environmentally sound manner.

Activity 2.3.1 Develop wetland products and markets that will provide jobs, increase local income, and partially offset operating costs. Wetland by-products of commercial value will be produced and market mechanisms developed. To the extent practical, wetland operations will promote local employment, increased incomes, and revenues to offset operating costs. The Project Manager through the Senior Project Engineer will be responsible for this activity.

Activity 2.3.2 Assess environmental and economic improvements and inform local residents. The ability of the wetland technology to increase family income, reduce pollution, and improve Lake quality will be communicated and demonstrated to local residents. Information will be provided to the local residents through media coverage, site visits, and local programs. The project benefits will be interpreted in terms of increased income to the people, reduced pollution, reduced occurrences of fish contamination, and a more sustainable fishery.

The potential impact to the Lake of expanded use of the wetland technology will be quantified. The long term environmental and economic benefits will be quantified in terms of Egyptian pounds per cubic meter of clean water produced and the economic worth of the products and labor produced. This will be compared with the costs and benefits of conventional technologies.

Output 2.4 Establish a monitoring and evaluation system to enable the Egyptian Environmental Affairs Agency (EEAA) to maintain expected performance levels.

Activity 2.4.1 Implement the monitoring plan on system performance and operation and establish an information distribution network. The Project Manager is responsible for determining the nature and scope of the data to be obtained from the engineered wetland. The Project Manager is also responsible for communicating the performance results to relevant government agencies, and developing a system of routine operational procedures. The operating organization will develop a checklist of parameters to act as performance indicators. Monitoring protocols will be evaluated on a six-month basis for relevance, procedural accuracy, reliability, sources of error, and adjusted as necessary by the Project Manager.

Activity 2.4.2 System operation to establish operating guidelines. Initial system operations will involve testing of alternative operating methods and procedures. Guidelines will be prepared recommending routine operating procedures.

SECTION E INPUTS

The technical discussion of key project components is given in Annexes I, IV, and V on project description, engineering design, and monitoring. Details on input quantities and estimated costs are provided in Annexes VII, VIII, and IX. A summary of the inputs by general project activity is given below.

E.1 Government of Egypt Inputs

Personnel	**Person Months**	
EEAA Representative	8	
Project Management Board	15	
Technical Focal Points	15	
Land		
Project Site	200 feddans	(84 hectares)

Miscellaneous
Egyptian visas and work permits
Necessary governmental approvals

E.2 UNDP Inputs

Personnel	**Person Months**
Project Manager	60
Senior Project Engineer	60
Secretary	60
Assistant/Driver	60
Legal Counsel	3
Operations Foreman	30
Unskilled Labor	120
Skilled Labor	30

Duty Travel
National Personnel

Mission Costs
Headquarters monitoring
Midform evaluation

Cairo Office	**Person Months**
Office space	60
Office furnishings	
Office equipment	
Car	
Operating expenses	60

Project Equipment
Truck and Trailer
Maintenance equipment
Monitoring and laboratory equipment

Project Operations	Person Months
Electricity	30
Expendable materials	30
Maintenance, repair, and replacement of parts	25

Subcontracts	Person Months
International wetland advisor	24
Design and construction supervision	
Construction	
Training and Monitoring	

Miscellaneous
UNDP Administration

SECTION F RISKS

As far as possible, the project is designed to minimize potential risks. For example, the wetland operates by gravity flow, contains redundant features, and minimizes mechanical and electrical complexity. No risks are present that call into question the viability or reliable operation of the project.

A review of the project identified potential operational and environmental risks that may occur with both routine activities and nonroutine events. The potential risks and contingency plans for dealing with each are as follows:

F.1 Implementation Schedule

After the approval of the project, local legal or sociopolitical problems could hinder implementation as scheduled.

Estimated Probability: Medium

Possible Corrective Measure: The GOE must obtain a project site in a location and manner which minimizes resistance to the project, ensures local support, and results in adequate security and access on the site.

The Project Manager must also ensure adherence to the project schedule. Potential delays in the schedule must be anticipated and resolved. Where necessary, sociopolitical problems should be immediately communicated to the EEAA and the responsible national agency. The Project Manager must ensure that problems are effectively solved and maintain the support of national and local decision makers.

F.2 Plant Availability or Propagation

The system design dictates the use of several types of aquatic plants, such as *Phragmites*, duckweed, and water hyacinths. There is a risk that the availability or rate of propagation of the plants will be lower than expected.

Estimated Probability: Low to medium

Possible Corrective Measure: If this occurs, the treatment system will be modified to temporarily use alternative plants.

F3. Pump Power Failure

Power failures in the project are not uncommon and will disrupt operation of the intake pump and other electrical facilities at the site.

Estimated Probability: High

Possible Corrective Measures: Short-term power failures will not be disruptive to operation of the wetland treatment system. No changes in operation are anticipated for outages of several hours. Longer outages during hot and dry periods could stress plants. In this case, the sediment basin will be drawn down below normal levels to provide minimum flows through the system.

F4. Variability in Water Quality

There is the possibility of variability in the quality of the source water flowing to the system which could slightly affect the stability and efficiency of treatment.

Estimated Probability: Low

Possible Corrective Measure: Flow rates and residence times within the system will be modified to maintain functionality. Operational modifications and monitoring will be used to develop effective operating procedures.

F.5 Market Value of Outputs

The harvested plant material or aquacultural output may not be utilized or may not produce the expected economic value.

Estimated Probability: Medium

Possible Corrective Measure: An environmentally and economically sound plan for storage or disposal of the accumulated material will be prepared. Operational modifications and market surveys will be used to maximize the net value of system outputs and by-products.

F6. Toxicity of Outputs

The dredged sediments, harvested plant material, or the aqua cultural products may contain toxic substances of human health significance or that render them unsuitable for some uses.

Estimated Probability: Medium

Possible Corrective Measures: All system by-products will be monitored for hazardous pollutants. Water, sediment, and biological samples will be collected and analyzed for metals, toxins, and other pollutants. Materials with unacceptable levels or a potential for adverse impacts will be disposed in an environmentally acceptable manner.

F7. Coordination

Implementation and coordination difficulties due to the number of national agencies and organizations involved in the project.

Estimated Probability: Medium

Possible Corrective Measure: The Project Manager will communicate regularly with all participants and modify plans as required to adapt to changing priorities and new opportunities. Regular evaluations of the project will be undertaken by the Project Manager, International Consultant, and UNDP staff. The Project Management Board will be encouraged to actively participate in the project through regular presentations and field trips.

F8. Vandalism of Site and Equipment

Vandalism of the project site and equipment could result in downtime or additional replacement and repair costs.

Estimated Probability: Medium

Possible Corrective Measures: A maximum on-site presence will be maintained. Regular police patrols will be encouraged. A good rapport with the local community, treating local participants fairly, and regular information concerning the benefits of the project will be priority items and insurance against vandalism.

SECTION G PRIOR OBLIGATIONS AND PREREQUISITES

G.1 Prior Obligations

Site acquisition, security, access, and the provision of electric power are prior obligations to be fulfilled by the GOE before the project document is signed. The site will be a minimum of 200 feddans in size, have an average land elevation of approximately 1 meter above the normal ground water elevation, and be located on the Bahr El Baqar drain in the vicinity of the El Salam Canal.

The project document will be signed by the UNDP, and the UNDP assistance to the project will be provided only if these prior obligations have been met to the satisfaction of UNDP.

G.2 Prerequisites

1. The GOE will give title for the 200 feddan (84 hectare) project site to the project without remuneration in care of EEAA as the Executing Agency.

2. The Government of Egypt agrees to contribute all GOE inputs described for them in their budget.

3. The GOE agrees that EEAA will act as the Executing Agency; that relevant government ministries will provide staff as needed for the Project Management Board and Technical Focal Points; and that other information and data will be provided as may be available on the project site and Lake Manzala.

4. The Government of Egypt agrees to participate fully and openly in a dialogue with all interested parties in regard to the future of Lake Manzala and to help forge the political will to reverse the significant deterioration of this water body.

5. As part of the GOE's contribution to the Engineered Wetland Project, all necessary permits, licenses and administrative requirements will need to be processed and approved in the first year of the project to permit the timely and efficient implementation of the project schedule. This undertaking will involve, *inter alia*, processing the following:

   5.1 Approval from the Council of Ministers under the provisions of Article 14 of Law No. 143 of 1981 to set aside the 200 feddans of land required for the establishment of the wetland and supporting facilities.

   5.2 Certification that the disposal of the designated area for the construction of the wetland shall be pursuant to the conditions and procedures outlined under the provisions of Article 2 of Law No 143 of 1981 Concerning Desert Lands.

   5.3 Permission from the General Authority for Reconstruction and Agricultural Development Projects under Article 10 of Law No 143 of 1981 for the establishment of buildings and other works required for the construction of the wetland.

   5.4 Certification from the inter-Ministerial Committee under the provisions of Article 20 of Law No. 124 (1983) regarding Fisheries, Aquatic Organisms, and the Organization of Fish Farms that any affected area of lake designated for the establishment of the wetland may be allowed to dry and be utilized for purposes other than fishery development.

   5.5 Exemption from the provisions of Article 18 of Law No. 124 (1983) regarding Fisheries, Aquatic Organisms, and the Organization of Fish Farms which prohibits the growing of any reeds or rhizome plants in fishing areas, together with the filling of any fishing area.

5.6 Approval under the provisions of Article 11 of Law No. 93 of 1962 in relation to Wastewater Disposal permitting the discharge of wastewater from the wetlands facility into the lake or any other watercourse.

5.7 Permission under the provisions of Article 14 Law No. 93 of 1962 to permit the discharge of treated water from the wetland facility, together with confirmation of the standards and requirements approved by the Minister of Health, and issued in a resolution by the Minister of Housing and Public Utilities.

5.8 Certification that the discharges from the wetland comply with the standards and specifications contained in Resolution No. 649 for 1962 pertaining to discharges into seas and lakes.

5.9 Issue by the Ministry of Irrigation of the license required under Article 2 of Law No. 48 (1982) Regarding the Protection of the River Nile and Waterways from Pollution together with the specification of the standards and requirements pertaining to discharges from the wetland, which shall be determined in consultation with the Minister of Health.

5.10 Exemption from the provisions of Article 12 of Law No. 48 of 1982 which prohibits the reuse of drainage water for any purpose.

5.11 Permission from the Ministry of Irrigation to discharge sediment upon the banks where necessary to construct the wetland, as required under the provisions of Articles 2 and 3 of Executive Regulations for the administration of Law No. 48 of 1982 provided in Ministerial Decree No. 8 (1983).

5.12 Permission from the Ministry of Irrigation to discharge from the wetland into Lake Manzala as required under the provisions of Article 38 of Law No. 48 of 1982.

5.13 Certification that the wastewater discharged from the wetland complies with the standards specified in Articles 66, 68, and 69 of Law No. 48 of 1982.

5.14 Exemption from the provisions of Article 15 of Law No. 124 of 1983 which prohibits the placement or discharge of any plant or residue into any waterway.

5.15 Certification that any pipes used for the construction of the wetland comply with standards specified in Articles 9 and 10 of Decree No. 8 of 1983 and Standard Specification No. 165 (1962) concerning Waste and Ventilation Pipes.

5.16 Certification that any fish farm established as part of the wetland complies with requirements under Section 3 of Law No. 124 of 1983.

5.17 Certification that any potable water utilized in the wetland project or generated as a result complies with requirements specified in Law No 27 (1978) on the organization of Public Sources of Potable Water and Water for Human Use.

5.18 Certification that the wetland engineering design complies with requirements specified under Law No. 106 (1976) concerning Building Works (as amended by Law No. 30 of 1983, Law No. 54 of 1984, and Law No. 99 of 1986).

5.19 Permission to utilize pumps for the wetland as required under Article 13 of Law No. 124 (1983) regarding Fisheries, Aquatic Organisms and the Organization of Fish Farms.

5.20 Certification that any bricks produced as a result of utilizing the waste material produced from the wetland project complies with standards specified in Standard Specification No. 1109 (1971) concerning Aggregates from Natural Sources and brick making facility which may be established complies with Decree No. 470 (1971) concerning the Norms of Atmospheric Pollution.

Additionally, the GOE will ensure that the project provides appropriate compensation to any displaced persons, as well as the deposit required under the provisions of Article 81 Law No. 48 (1982).

The GOE will also ensure that there is an appropriate body to manage the Engineered Wetland at the end of the five-year project period (including but not limited to the provision of power for pumping and other operational needs). The GOE will take steps to ensure that there is an orderly transition to this body from EEAA should EEAA not be the selected organization.

The project document will be signed by the UNDP, and UNDP assistance to the project will be provided, subject to the UNDP receiving satisfaction that the prerequisites listed above have been fulfilled or are likely to be fulfilled. When anticipated fulfillment of one or more prerequisites fails to materialize, UNDP may, at its discretion, either suspend or terminate its assistance.

SECTION H PROJECT REVIEW, REPORTING, AND EVALUATION

The project will be subject to tripartite review (joint review by representatives of the Government, Executing Agency, and UNDP) once every 12 months, the first such meeting to be held within the first 12 months of implementation. The Project Manager will prepare a Project Performance Evaluation Report (PPER) and submit to the UNDP prior to each tripartite review meeting. Additional PPERs may be requested, if necessary, during the project.

Every 12 months the International Consultant will conduct an independent review of the project's progress and submit a summary report to the Project Management Board, UNDP, and the Executing Agency.

An annual report to the Project Management Board will be prepared by the Project Manager. The report will summarize progress, results, system performance, local participation, and expenditures. Copies will be distributed to relevant agencies and project participants. A midterm evaluation will be conducted after 30 months. The evaluation will be carried out by persons independent of the project in order to provide an objective evaluation.

A project terminal report will be prepared for consideration at the terminal tripartite review meeting. It will be prepared in draft sufficiently in advance to allow review and technical clearance by the Executing Agency at least four months prior to the terminal tripartite review.

Additional details for this component are presented in Annex III.

SECTION I LEGAL CONTEXT

This project document shall be the instrument referred to as such in Article 1 of the Standard Basic Assistance Agreement between the Government of Egypt and the United Nations Development Program, signed by the parties on 19 January 1987. The host country implementing agency shall, for the purpose of the Standard Basic Assistance Agreement, refer to the government cooperating agency described in that Agreement.

The following types of revisions may be made to this project document with the signature of the UNDP resident representative only, provided he or she is assured that the other signatories of the project document have no objections to the proposed changes:

A. Revisions in, or addition of, any of the annexes of the project document.

B. Revisions which do not involve significant changes in the immediate objectives, outputs, or activities of a project, but are caused by the rearrangement of inputs already agreed to or, by cost increases, due to inflation.

C. Mandatory annual revisions which rephase the delivery of agreed project inputs, or reflect increased expert or other costs due to inflation, or take into account agency expenditure flexibility.

SECTION J BUDGET

Budget tables are provided for the Government of Egypt's contribution in kind (in L.E.) and for the UNDP (in U.S. $). Annex IX contains a detailed listing and additional explanation of the individual budget lines.

Table 1. Project budget for government of Egypt contribution in L.E.

Budget Line		TOTAL		YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5	
		Person/Months	**LE**	**Person/Months**	**LE**	**Person/Months**	**LE**	**Person/Months**	**LE**	**Person/Months**	**LE**	**Person/Months**	**LE**
10	**Personnel**												
11.01	EEAA Representative	8	80,420	2	19,000	2	19,580	1	10,080	1	10,380	2	21,380
11.02	Project Management Board	15	189,650	4	48,000	4	49,440	2	25,460	2	26,220	3	40,530
11.03	Technical Focal Points	15	110,640	4	28,000	4	28,840	2	14,860	2	15,300	3	23,640
19	**Personnel Component Total**	**38**	**380,710**	**10**	**95,000**	**10**	**97,860**	**5**	**50,400**	**5**	**51,900**	**8**	**85,550**
40	**Equipment**												
43.01	Land for Project	200 Feddans	1,600,000										
49	**Equipment Component Total**		**1,600,000**										
50	**Miscellaneous**												
51	Egyptian visas and work permits												
52	Necessary governmental approvals												
59	**Miscellaneous Component Total**												
	TOTAL	**38**	**1,980,710**	**10**	**95,000**	**10**	**97,860**	**5**	**50,400**	**5**	**51,900**	**8**	**85,550**

Table 2. Project budget for UNDP contribution in U.S. $.

Budget Line		TOTAL		YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5	
		Person/Months	**US $**	**Person/Months**	**US $**	**Person/Months**	**US $**	**Person/Months**	**US $**	**Person/Months**	**US $**	**Person/Months**	**US $**
10	**Project Personnel**												
15	**Duty Travel**												
15.01	National personnel		40,000		8,000		8,000		8,000		8,000		8,000
15.99	**Subtotal duty travel**		**40,000**		**8,000**		**8,000**		**8,000**		**8,000**		**8,000**
17	**National Project Professional Personnel (NPPP)**												
17.01	Project Manager	60	210,000	12	39,600	12	40,800	12	42,000	12	43,200	12	44,400
17.02	Senior Project Engineer	60	173,500	12	32,400	12	33,600	12	34,800	12	35,800	12	36,900
17.03	Secretary	60	48,000	12	9,024	12	9,312	12	9,600	12	9,888	12	10,176
17.04	Assistant/Driver	60	60,000	12	11,280	12	11,640	12	12,000	12	12,360	12	12,720
17.05	Legal Counsel	3	9,000	3	9,000								
17.06	Operations Foreman	30	12,000					6	2,280	12	4,800	12	4,920
17.07	Unskilled Labor	120	24,000					24	4,560	48	9,600	48	9,840
17.08	Skilled Labor	30	10,500					6	1,995	12	4,200	12	4,305
17.99	**Subtotal NPPP**	**423**	**547,000**	**51**	**101,304**	**48**	**95,352**	**84**	**107,235**	**120**	**119,848**	**120**	**123,261**
19	**Personnel Component Total**	**423**	**587,000**	**51**	**109,304**	**48**	**103,352**	**84**	**115,235**	**120**	**127,848**	**120**	**131,261**
20	**Subcontracts**												
21	International wetland consultant	24	450,000	6	110,000	5	90,000	5	90,000	4	80,000	4	80,000
22	Design and construction supervision		290,000		190,000		70,000		30,000				
23	Construction		1,970,000				1,300,000		670,000				
24	Design modifications		30,000						30,000				
25	Monitoring and analyses	27	100,000					3	10,000	12	35,000	12	55,000
29	**Subcontracts Component Total**	**51**	**2,840,000**	**6**	**300,000**	**5**	**1,460,000**	**8**	**830,000**	**16**	**115,000**	**16**	**135,000**
40	**Equipment**												
41	Expendable equipment												
41.01	Office utilities/supplies	60	42,000	12	8,400	12	8,400	12	8,400	12	8,400	12	8,400
41.02	Site utilities	30	56,000					6	10,600	12	22,400	12	23,000
41.03	Site materials	30	48,000					6	9,600	12	19,200	12	19,200
42	Non-expendable equipment												
42.01	Office furnishings		5,000		5,000								
42.02	Office equipment		15,000		15,000								
42.03	Office car		20,000		20,000								
42.04	Site truck and trailer		30,000						30,000				
42.05	Site maintenance equipment		15,000						15,000				
42.06	Site monitoring equipment		36,000						36,000				
42.07	Site laboratory equipment		64,000						64,000				
43	Premises												
43.01	Office space	60	60,000	12	12,000	12	12,000	12	12,000	12	12,000	12	12,000
49	**Equipment Component Total**	**180**	**391,000**	**24**	**60,400**	**24**	**20,400**	**36**	**185,600**	**48**	**62,000**	**48**	**62,600**
50	Miscellaneous												
50.01	Site maintenance, repair, and replacement of equipment	25	62,000					1	2,480	12	29,760	12	29,760
50.02	UNDP Administration		120,000		24,000		24,000		24,000		24,000		24,000
59	**Miscellaneous Component Total**	**25**	**182,000**		**24,000**		**24,000**	**1**	**26,480**	**12**	**53,760**	**12**	**53,760**
	TOTAL	**679**	**4,000,000**	**81**	**493,704**	**77**	**1,607,752**	**129**	**1,157,315**	**196**	**358,608**	**196**	**382,621**

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SECTION K ANNEXES

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ANNEX I. PROJECT DESCRIPTION AND RATIONALE FOR DESIGN

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ANNEX I PROJECT DESCRIPTION AND RATIONALE FOR DESIGN

1.0 General Project Setting and Design Rationale

Of the five major drains that carry wastewater into Lake Manzala, the Bahr El Baqar drain is the most polluted and contains a large range of particulates, nutrients, metals, organics, and other toxic compounds. The drain receives inputs from numerous point and nonpoint sources before reaching the Lake. Sewage from Cairo, wastewaters from industries, agricultural discharges from farms, and discharges and spills from boat traffic are major sources of pollution.

The short-term objectives of this project include designing, constructing, operating, and monitoring an engineered constructed wetland. The purpose of the wetland demonstration project is to illustrate the utility of an inexpensive wastewater treatment complex to treat up to 50,000 m^3/day* of effluent from the Bahr El Baqar drain and to provide economic benefits to local residents. The long-term objectives include expediting adoption of the most promising components of the technology to provide additional treatment and local economic benefits. The impact of these actions will benefit Lake Manzala, the Mediterranean Sea and the local population. Wetland treatment systems are effective and often provide more affordable treatment than conventional methods. Wetlands offer opportunities for sustainable rural and urban economic growth, with good potential for commercial utilization of biomass and sludge.

The preliminary design will incorporate a diversity of treatment options to allow primary, secondary, and tertiary treatments (i.e., sedimentation, substantial treatment and removal, and final polishing), along with resource recovery of plant proteins (duckweed and canary grass) and aquaculture from the Lake Manzala strain of tilapia. The design of the treatment system will incorporate functional objectives which focus on improving the water quality of Lake Manzala. The design will be based on the following site-specific characteristics:

A. Wastewater in Bahr El Baqar drain is composed of particulates, nutrients, heavy metals, hydrocarbons, and residues of toxic compounds such as herbicides and pesticides. During high flow, the drain water also has large quantities of suspended sand, silt, and clay which provide adsorption sites for dissolved metals and other contaminants.

B. Flow volumes undergo significant diurnal and seasonal fluctuations created by fluctuating water uses and discharges along the drain.

C. Many of the pollutants are adsorbed by the settleable and suspended solids in the water and are subsequently transported to Lake Manzala where they settle out in the shallow bottoms.

* Actual treatment capacity could be less than 50,000 m^3/day if the ground elevation of the project site requires excessive fill and/or dewatering. All subsequent preliminary design calculations and cost estimates in the document are based on a site elevation of 1 meter above the normal groundwater level and a treatment capacity of 50,000 m^3/day.

D. Lake Manzala and the Bahr El Baqar drain are vital to the local population. There is an expectation that international technical and scientific assistance can lead to a greater and safer use of the waters for traditional practices, such as fish farming and agriculture. The socioeconomic and cultural infrastructure in the region supports the use of low-technology and sustainable development strategies. This suggests the need for developing wastewater treatment designs which can also produce opportunities for commercial utilization of the biomass. This requires that a significant part of the biomass produced in the wetland will be protected from the toxicity of the metals and chemicals. Thus, metals and toxic compounds must be removed before they are accumulated in plant or fish tissues.

E. Lake Manzala is a hydraulic link between the influent drains and the Mediterranean Sea. If the wetland technology is adopted at other sites, it can enhance the lake environment and protect the Mediterranean Sea. It is envisaged that the success of this initiative will result in the development of similar systems in other areas of Egypt and the Arab region.

2.0 Characteristics of Water in the Bahr El Baqar Drain

Water quality characteristics, as revealed by data collected in 1992 and 1993, indicate considerable diurnal and seasonal variations. The high sediment load in the drains consists of approximately 65 percent sand, 23 percent silt, and 12 percent clay material. Although the settleability of the sand fraction is rapid, the deposits undergo constant accretion and erosion creating a mobile sediment bed in the drain channel. Sediment-adsorbed organic carbon ranges from about 17 percent to 75 percent of the total organic carbon levels and is indicative of a high potential for adsorption of metals. This is further supported by the trace metal data in the water and sediments. Table I-1 shows the partition of selected heavy metals in the water and sediments.

Table I-1. Selected heavy metals in water and sediments.

Metals	Units	Zn	Mn	Fe	Pb	Hg	Cd
Water	ppb	0.076	0.35	0.45	0.32	0.37	0.40
Sediment	ppm	164.21	481.70	2.45	95.3	0.44	0.15

Note: Water samples were analyzed by the Central Laboratory for Aquaculture Research, Abbassa. Sediment samples were analyzed by the National Institute for Oceanography and Fisheries, Alexandria. Data are from 1993 sampling (Lane and Associates Limited, 1993).

Since the sediment carries a large fraction of the metal contaminants, removal by the sedimentation basin will provide primary pretreatment prior to secondary and tertiary treatment in the constructed wetlands.

Constantly fluctuating pollutant and sediment concentrations in the drain water are due to variations in the flow velocity, flow depth, and influent quality produced by hundreds of inputs and discharges into and from the drain along the route to Lake Manzala. Hydrometric measurements conducted in 1992 and 1993 show that both water depth and current velocity can change rapidly within a day and between various sampling sites on the same day. Between June 6 and June 10, 1993, at Station 93-1, the current velocity changed from 0.44 m/s to 0.14 m/s. At station 93.1, past records show that the annual variation in the monthly mean flow ranged from about 5 m^3/s in July of 1988 to about 35 m^3/s in January of 1989, and decreased to about 8 m^3/s in July of 1989.

The variation in total suspended solids (TSS) was studied for a 24 hour period at Station 93-1 and for a 12 hour period at Station 93-6. Station 93-1 showed a continuous fluctuation of TSS between a maximum value of 280 mg/L and a minimum value of 60 mg/L. This variation was composed of several cyclical changes in TSS, with periods alternating between two and three hour intervals. The cycle beginning at 2100 hours had a four hour period, and the second highest maximum. In contrast, the 12 hour measurements taken at Station 93-6 during the same timeframe showed very little variation in TSS values. All TSS samples were taken at about 0.5 m below the surface. This further augments the difficulty in estimation of the trend in the sediment load and, hence, the pollutant load carried by the sediments. As mentioned before, the sediment concentration is the most important water quality parameter for the design of the treatment system. The following table shows data obtained from hydrometric and bed level measurements conducted in 1988 and 1989 at the Bahr El Baqar bridge by the Drainage Research Institute.

Table I-2. Changes in flow rate and bottom bed level in Bahr El Baqar drain at the bridge.

Parameter	Units	20/07/88	21/11/88	04/12/88	17/01/89	14/02/89	26/03/89
Flow Rate (m^3/s)	m^3/s	3.19	22.49	25.07	34.90	24.73	16.37
Bed Level below msl	m	1.51	1.69	1.70	1.89	1.83	1.88
Parameter		16/04/89	24/05/89	28/06/89	08/07/89	02/08/89	-
Flow Rate	m^3/s	12.38	8.51	12.21	10.20	8.08	-
Bed Level (m) below msl	m	1.90	1.93	1.87	1.92	1.81	-

Erosion of the sediment bed is predominant when flows increase in the drain and both erosion and accretion become evident from February to July when flow rates begin to decrease. The sediment load in the drain follows a similar variation during the year. Settleability tests conducted in 1992 showed that the average TSS in the sediment profile reached a near equilibrium concentration of about 660 mg/L in about 48 hours. However, this value is based on high sediment loads and whole column water sampling. An inflow TSS value of 160 mg/L more accurately reflects concentrations in the upper reaches of the water column from which the inflow will be obtained.

Initially, operation of the wetland treatment system will be in experimental mode to optimize treatment efficacy based on loading rates, retention times, and the physical, chemical, and biological treatment processes. This will allow development of operating procedures based on site-specific conditions.

Table I-3 summarizes expected influent water quality to the treatment system. Water quality values are based on averages derived from various monitoring efforts within the past five years.

Table I-3. Design water quality data (influent) for treatment by engineered wetland system.

Parameter	Units	Value
Daily flow	m^3	50,000*
Total BOD	mg/L	30
Total COD	mg/L	100
Total Suspended Solids	mg/L	160
Total Phosphorus	mg/L	5
Total Nitrogen	mg/L	10
pH		7.5
Conductivity	micromhos/cm	2300

3.0 Wetland Design

3.1 Basic Engineering Design of the Treatment System

Each of the components of the proposed system and their relative positions are illustrated in Figures I-1 and I-2. Figure I-3 provides a longitudinal cross section of the wetland beds in relation to the existing grade and sea level.

The following are the principal components of the treatment system:

A. Sedimentation Basin;
B. Engineered Surface-flow Wetland Treatment Beds (primary and secondary), planted to aquatic macrophytes and/or floating duckweed;
C. Engineered Subsurface flow Wetland (reciprocating system), planted to emergent aquatic and/or terrestrial species with emphasis on high value;
D. Aquaculture Hatchery and Fingerling Production Ponds, with emphasis on the Lake Manzala strain of tilapia (*Oreochromis niloticus*)

* Actual treatment capacity could be less than 50,000 m^3/day if the ground elevation of the project site requires excessive fill and/or dewatering. All subsequent preliminary design calculations and cost estimates in the document are based on a site elevation of 1 meter above the normal groundwater level and a treatment capacity of 50,000 m^3/day.

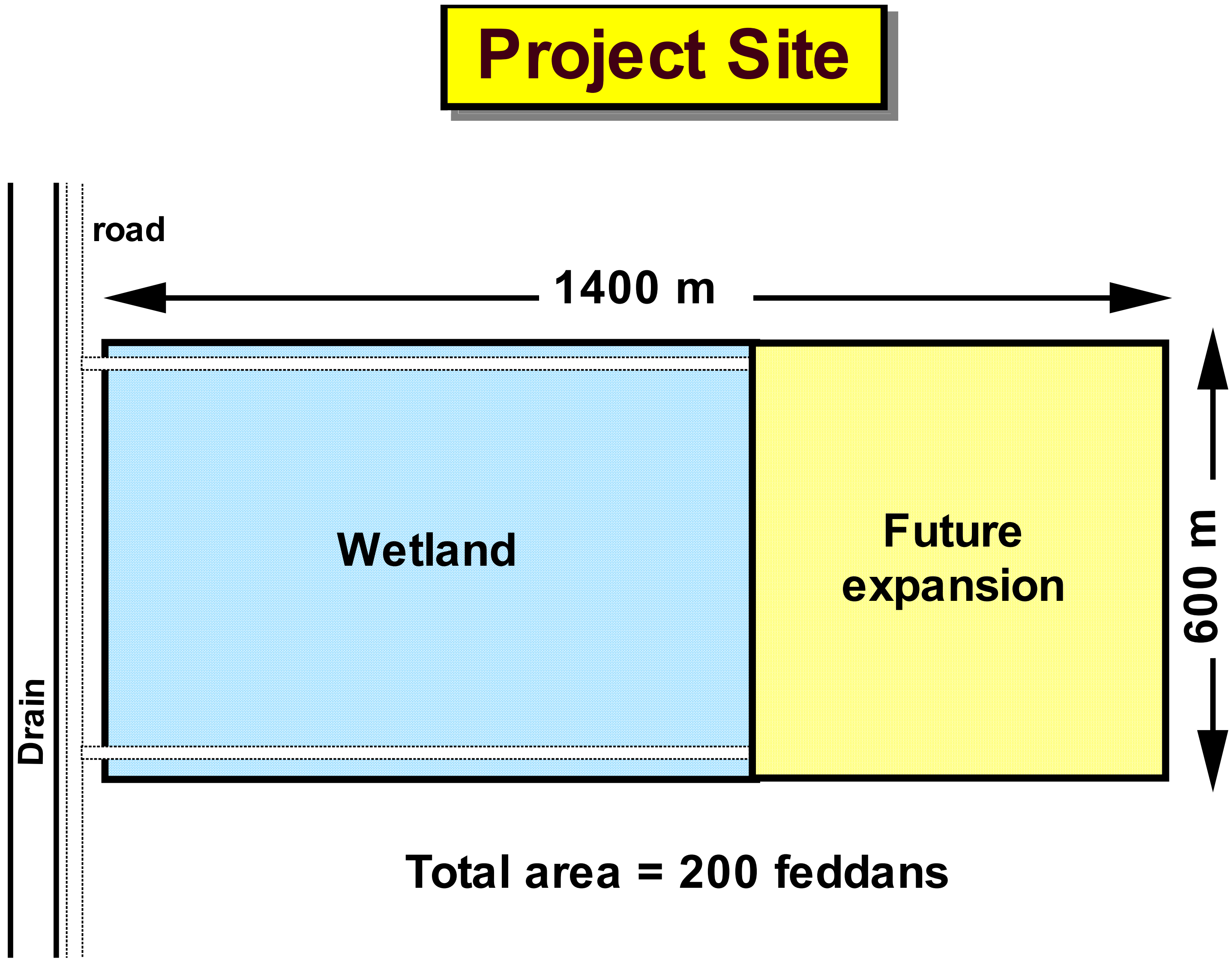

Figure I-1. Proposed site area for development of Lake Manzala wetland.

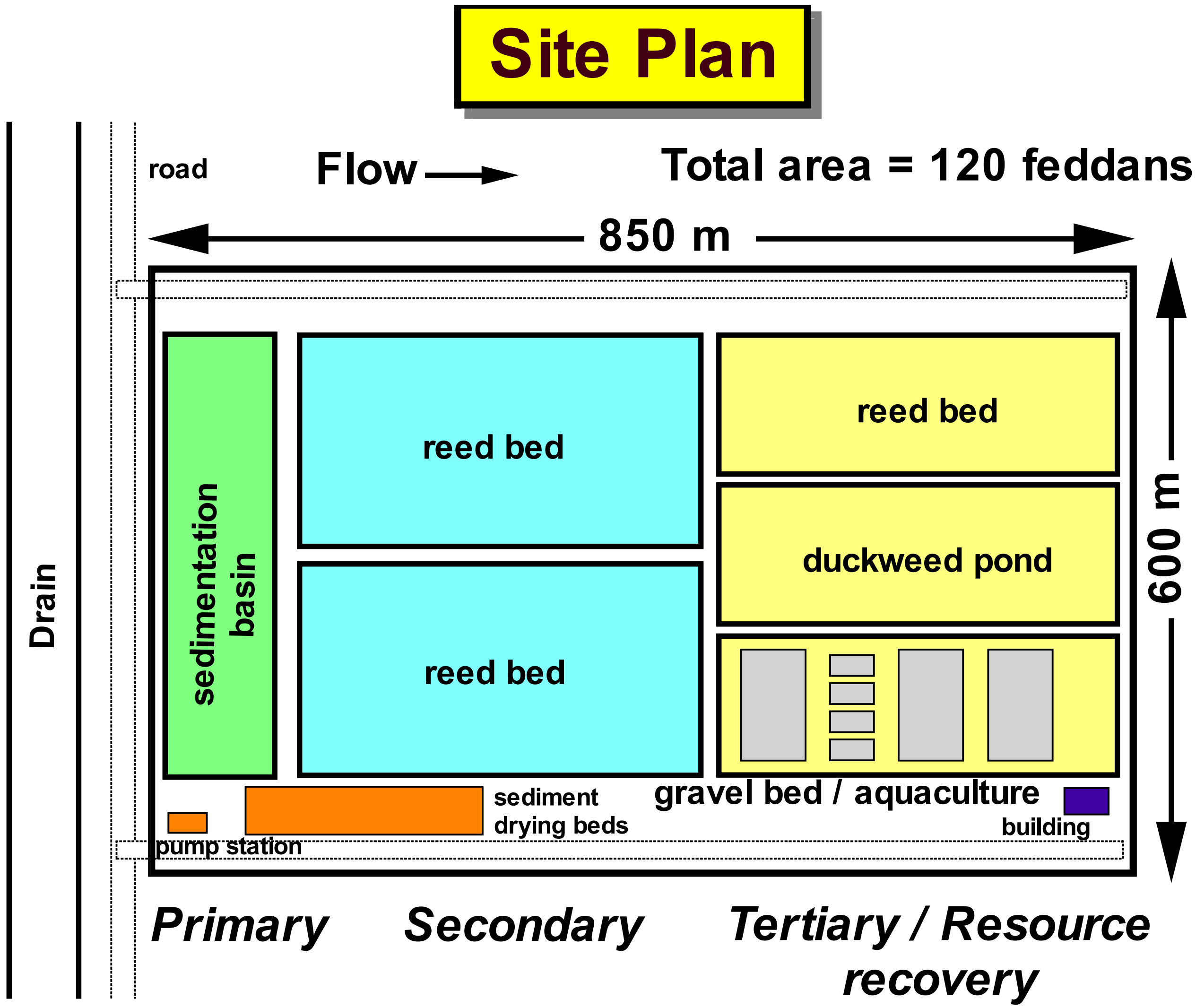

Figure I-2. Plan view of proposed Egyptian engineered wetlands complex with aquaculture resource recovery option

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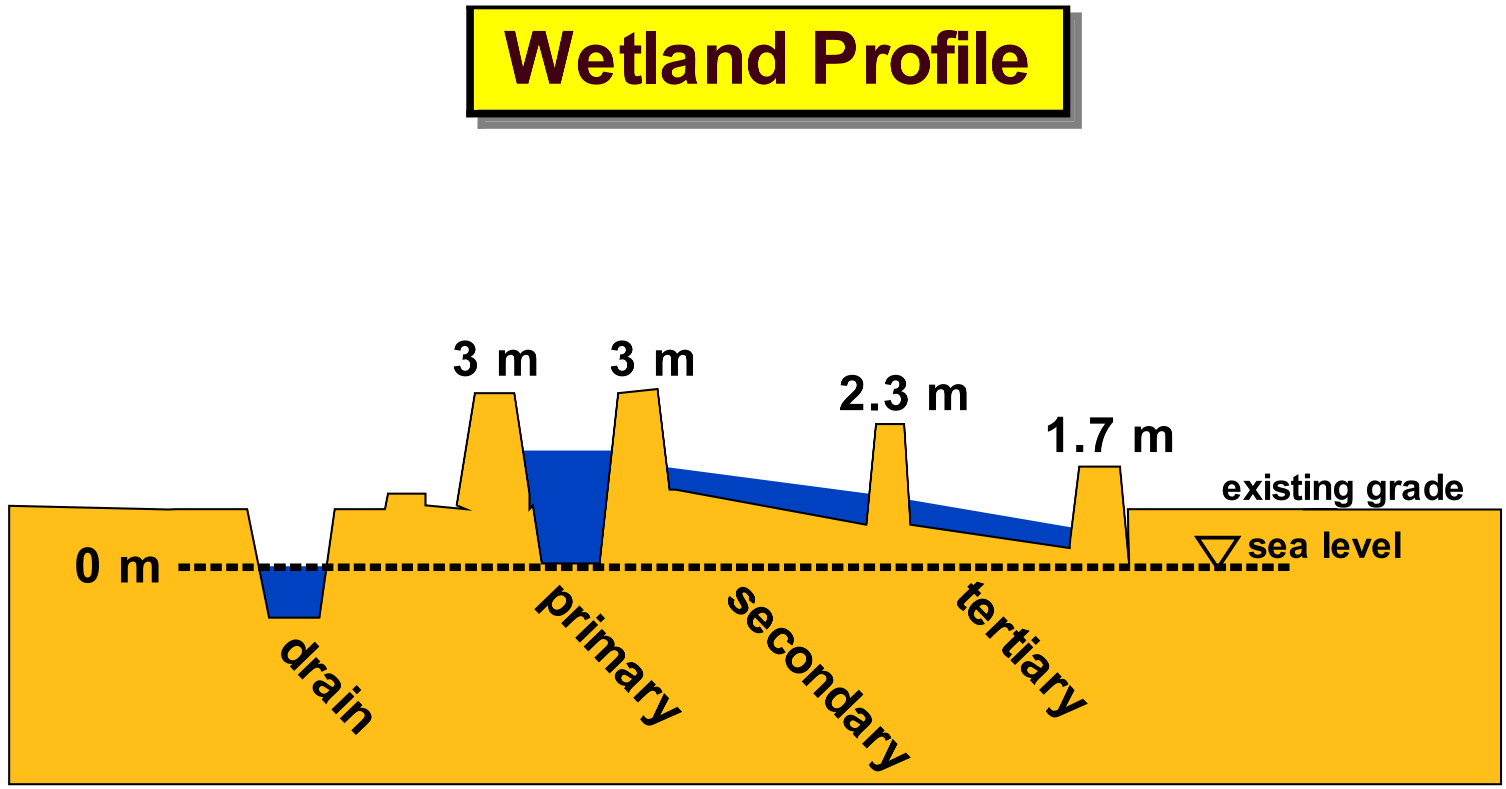

Figure I-3. Preliminary illustration of Egyptian engineered wetland complex with respect to existing grade and sea level. Primary sector represents a cross-section view of the sedimentation basin, while the secondary and tertiary sectors refer to serial wetland compartments inclduing reed beds, duckweed beds, reciprocating gravel beds, and aquaculture ponds.

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The proposed engineered wetland complex and associated facilities include:

A. Intake structure (offset from the drain), and water delivery system including the intake manifold, sumps, pump housing and the delivery weir to the sedimentation basin;
B. Sedimentation basin.
C. Discharge structure to convey wastewater from the sedimentation basin to the surface-flow engineered wetlands.
D. Delivery and discharge structures to convey water from secondary wetland beds to tertiary treatment beds, including reed bed, duckweed bed, and subsurface-flow reciprocating system.
E. Delivery and discharge structures to convey water from reciprocating system to aquaculture hatchery and fingerling ponds.
F. Discharge structures to convey water from the aquaculture facilities and secondary treatment beds (reed beds and duck weed) to the Lake.

The intake structure will be designed and offset from the main canal to minimize current velocity and entrainment of bottom sediments. The drain water will be channeled into the offset pumping station which will be outfitted with a screen to remove floating debris and plant material (water hyacinths). The final entry into the next stage of the pumping scheme will be a control structure such as a weir. The wetwell will provide sufficient volume and depth for efficient pumping cycling.

Water will be conveyed to the pump through a short section of intake pipe. It is suggested that centrifugal, screw, or similar pumps be used that are suitable for high volume, low head, nonclog service. The pump discharge will be piped to the sediment basin, entering near the drying bed. Conceptual design and operational guidelines are provided in Annex IV.

3.2 Wastewater Treatment Components

Tables I-4 and I-5 summarize design parameters for each system component. The following sections describe the function of each component in the overall wastewater treatment process.

3.2.1 Sedimentation Pond

Wastewater will be pumped into a rectangular sedimentation basin through a weir-type inlet. The sedimentation basin will have a volume of 100,000 m^3 and a hydraulic retention time of two days. Preliminary tests indicate that the inflow suspended solids contain about 65 percent sand fraction and 35 percent silt and clay fraction. The sedimentation basin will be designed for a minimum settling efficiency of 50 percent. Parallel cells or other flow barriers will be used as needed to prevent short circuiting and facilitate sediment removal. The sediment accumulation will be dredged or manually removed to conventional drying beds several times per year. Approximately 1500 m^3/year are anticipated. The dried sediment will be tested for contaminants and, if suitable, used for construction or fill material.

Table I-4. Drain water inflow characteristics.

Inflow	Units	Total BOD	Total COD	TSS	TP	TN
Concentration	mg/L	30	100	160	5	10
Daily	tons	1.50	5.00	8.00	0.25	0.50
Yearly	tons	548	1825	2920	91	182

Table I-5. Preliminary design parameters for the Egyptian Engineered Wetlands Project, 1996.

Parameters	Units	Sediment Basin	High flow Secondary Reed Bed	Low flow Secondary Reed Bed	Tertiary Reed Bed	Tertiary Duckweed Bed	Tertiary Recip. Gravel Bed	Hatchery and Fingerling Ponds
Flow	m^3/d	50,000	41,000	9,000	41,000	7,000	2,000	2,000
Volume*	m^3	100,000*	37,500	37,500	25,000	25,000	4,000*	30,000
Area	m^2	50,000	75,000	75,000	50,000	50,000	10,000	30,000
Depth	m	2	0.5	0.5	0.5	0.5	1	1
Detention	d	2	0.9	4.2	0.6	3.6	2	12

*Active storage volume, excluding sediment storage, plant biomass, and gravel volume.

3.2.2 Engineered Wetlands: Emergent Plants

Emergent plants such as cattail (*Typha latifolia*), bulrush (*Scirpus spp.*), and reed (*Phragmites communis*) act as efficient filters for suspended solids, and can probably be used interchangeably in wetland treatment systems. For this application, a monoculture of the endemic common reed (*Phragmites communis*) as the emergent plant is recommended since it has high biomass potential, responds to selective harvesting, and has potential commercial uses.

Emergent plants will be used in the secondary treatment section of the wetland to substantially improve water quality before the wastewater reaches the tertiary series of wetland beds. The tertiary beds will contain either common reed or canary grass (*Phalaris arundinacea*) and duckweed for effluent polishing. In some treatment wetlands, TSS removal rates as high as 90 percent or more have been observed. Emergent plants can also absorb and sequester heavy metals from water and sediments mostly in the rhizomes, or in the outer oxidized layer (scale-like formation) of the roots and root hairs. A small portion of the metals thus absorbed can be translocated from the roots and rhizomes to the above-ground stems, leaves, and seeds.

Considerable improvement in the secchi depth or turbidity can be achieved in the wastewater during passage through the secondary treatment emergent wetland. This enhances the transmission of light which encourages photosynthesis in attached and benthic algae. Algae are specifically effective in absorbing heavy metals from water and sediments and adding oxygen to enhance removal of biological oxygen demand. Various species of green and blue-green algae have been used in natural and engineered wetland systems to treat mining effluents and remove metals. The major role of the secondary wetland beds is removal of TSS, BOD, and heavy metals.

3.2.3 Engineered Wetlands: Floating Plants

Water hyacinths have been used extensively to remove nutrients, suspended sediments and pollutants from wastewaters in engineered wetlands. Water hyacinth can be managed to produce high biomass yields and marketable products such as animal feed, fuel pellets and methane. It is essential to ensure that the biomass is free of toxic pollutants so that the end products do not pose health and environmental hazards.

Duckweed (*Lemna spp*,) is another alternative floating plant that can remove algal and particulate turbidity, nutrients and dissolved metals. Duckweeds are especially beneficial in a resource recovery program because of their high protein content (30-40 percent protein on a dry matter basis), and their near optimum amino acid profile. These small floating plants are easily harvested by skimming and netting, and have a high digestibility coefficient when fed to tilapias and grass carp. It is proposed that one of the tertiary treatment beds be planted to duckweed and canary grass, both of which can be harvested for use as fodder and feed for tilapia and grass carp, respectively. It is anticipated that up to 5 percent of the duckweed biomass can be harvested on a weekly basis without reducing overall productivity and treatment efficacy. Canary grass can also be harvested (leaves and stems) but usually only on a monthly basis and only to the extent that it is cropped back to the original planting arrangement. The primary function of the canary grass, which spreads slowly, is to act as a living hedge row to prevent the duckweed from being windswept to the shoreline. Canary grass, also has a high protein content and a high palatability for grass carp and ruminants.

The choice of using emergent macrophytes, benthic and attached algae, and floating plants in the proposed sequence will ensure that: 1) suspended solids are removed well before the wastewater flows to the secondary wetland beds for nutrient polishing, 2) substantial water clarity is achieved in the submergent wetland for better light penetration and photosynthesis; and 3) heavy metals and toxic chemicals are removed before reaching the floating plant beds so that the harvested plants (canary grass and/or duckweeds) are free from any toxic contamination. The wetland design will emphasize the unique economic and environmental benefits which can be derived from wetland treatment systems, particularly in a developing country.

3.2.4 Reciprocating Gravel Wetland System and Aquaculture Facility

The aquaculture facility will receive effluent water from a 1 hectare (ha) reciprocating wetland system designed for tertiary treatment. The aquaculture resource recovery module will consist of four hatchery ponds, each with about 0.1 ha surface area and two fingerling production ponds, each with approximately 1 ha of surface area. The ponds will be approximately 1 m deep with bottom slopes sufficient to drain into internal catch basins to facilitate complete harvesting. Figure I-4 provides a plan view of the proposed aquaculture facility and reciprocating wetlands module. The aquaculture facility will be a proof-of-concept facility to demonstrate that the wetlands are capable of cleaning water to the extent that fish culture activities can be safely and economically practiced. Furthermore, the hatchery can be the basis for development of a restocking program to augment tilapia production in Lake Manzala. It is anticipated that with current pond-based hatchery technology, it will be possible to produce up to 5,000,000 fingerlings per year. No special operating procedures are expected since the growing season in northern Egypt extends throughout most of the year. Although daytime temperatures can approach 15 degrees C in the winter, the impact on fish and aquatic plants is small because of the relatively short winter. Diurnal temperature variations in the fish ponds are less than air variations because of the thermal holding capacity of water.

3.3 Wetland Performance

The wetlands are proposed to operate under three treatment options. All treatment options involve 50,000 m^3/d through the sedimentation basin. A high-flow treatment consists of 41,000 m^3/d through a secondary reed bed and then through a tertiary reed bed. The other two treatment options have the remaining 9000 m^3/d passing through a secondary reed bed. Of this 9000 m^3/d, 7000 m^3/d passes through a tertiary duckweed bed. The third treatment option consists of 2000 m^3/d passing through a reciprocating gravel-bed wetland.

Using the flow patterns described above, conservative estimates for the removal of TSS, TP, TN, and BOD have been determined for the effectiveness of the sedimentation basin and individual wetland components. Tables I-6, 7, and 8 provide estimates of removal

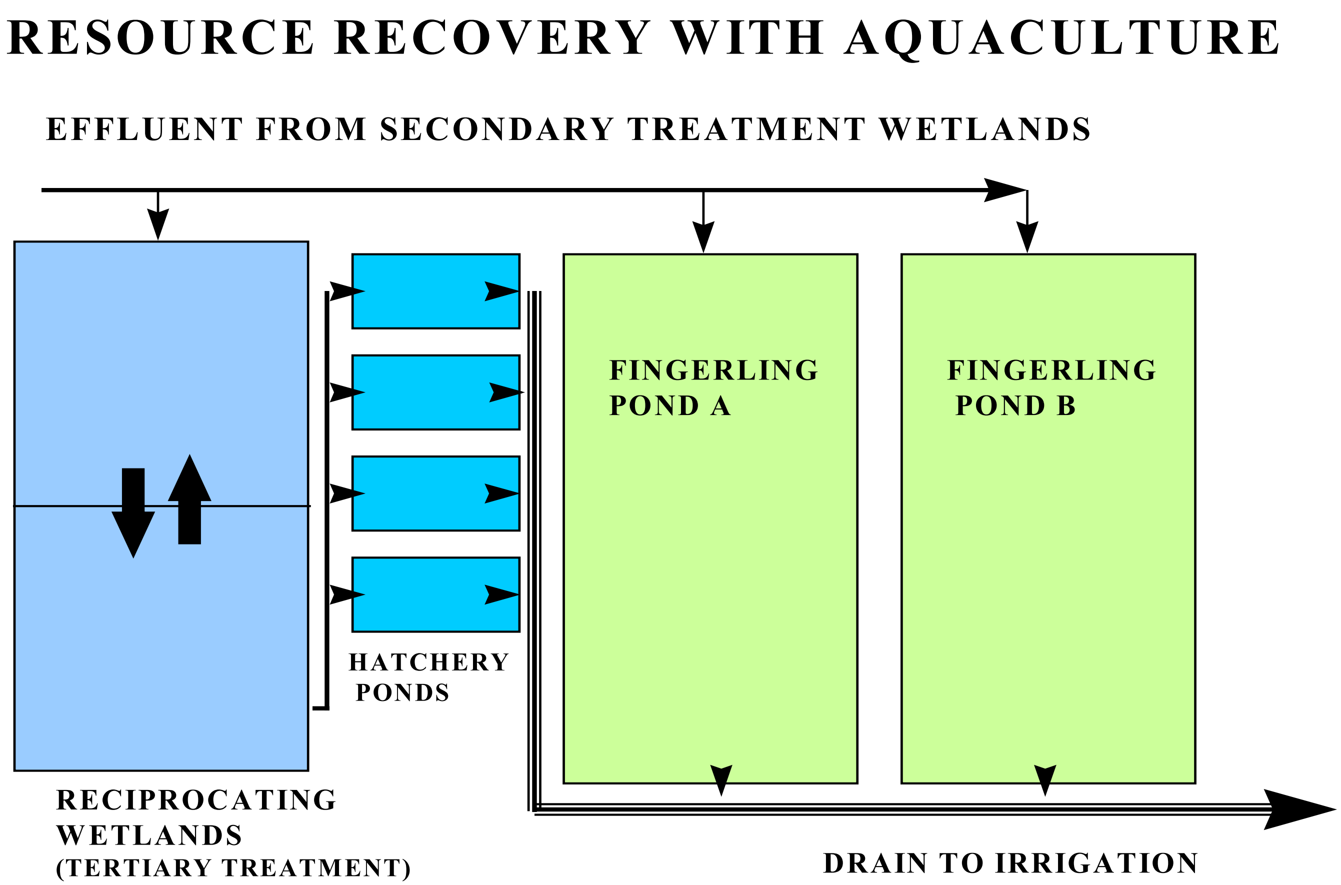

Figure I-4. Proposed layout of aquaculture facility including reciprocating module for tertiary wastewater treatment, four tilapia hatchery ponds and two fingerling production ponds. Respective areas of the components are 1 ha. reciprocating unit, 0.1 ha (four each) hatchery ponds, and 1 ha. (two each) fingerling production ponds.

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Table I-6. Estimated removal efficiencies* for individual wetland components.

Bahr El Baqar drain Initial Conditions		Sedimentation Pond			High Flow Secondary Reed Bed			Low Flow Secondary Reed Bed		
Parameter	Influent Drain conc. mg/L	Influent conc. mg/L	Effluent conc. mg/L	Removal Efficiency %	Influent conc. mg/L	Effluent conc. mg/L	Removal Efficiency %	Influent conc. mg/L	Effluent conc. mg/L	Removal Efficiency %
TSS	160	160	80	50	80	18.3	39	80	17.9	39
BOD	40	40	24	40	24	21.0	8	24	13.6	26
Total P	5	5	4	25	4	3.5	4	4	2.9	18
Total N	12	12	12	0	12	10.9	9	12	7.9	35
Organic N	2	2	2	0	2	2.0	2	2	1.8	8
Ammonium N	10	10	10	0	10	8.9	11	10	6.0	40

		Tertiary Reed Bed			Tertiary Duckweed Bed			Tertiary Reciprocating Gravel Bed		
		Influent conc. mg/L	Effluent conc. mg/L	Removal Efficiency %	Influent conc. mg/L	Effluent conc. mg/L	Removal Efficiency %	Influent conc. mg/L	Effluent conc. mg/L	Removal Efficiency %
TSS	160	18.3	8.4	6	17.9	9.0	6	17.9	9.0	6
BOD	40	21.0	19.3	4	13.6	6.8	17	13.6	6.8	17
Total P	5	3.5	3.4	3	2.9	1.4	29	2.9	0.6	46
Total N	12	10.9	10.3	5	7.9	3.9	33	7.9	0.8	59
Organic N	2	2.0	1.9	1	1.8	0.9	46	1.8	0.2	83
Ammonium N	10	8.9	8.3	6	6.0	3.0	30	6.0	0.6	54

*Removal efficiencies are calculated as a percentage reduction relative to the influent drain concentration. Removal efficiencies for individual wetland components are not shown, but can be calculated as: (component influent concentration-component effluent concentration) x 100 / component influent concentration.

Table I-7. Estimated treatment efficiency as a function of alternative flow paths.

Parameter[4]	Influent conc. mg/L	High Flow Volume[1]		Low Flow Volume[2]		Low Flow/Reciprocating Gravel Bed[3]	
		Effluent conc. mg/L	Removal Efficiency %	Effluent conc. mg/L	Removal Efficiency %	Effluent conc. mg/L	Removal Efficiency (%)
TSS	160	8.4	95	9.0	94	9.0	94
BOD	40	19.3	52	6.8	83	6.8	83
Total P	5	3.4	32	1.4	71	0.6	89
Total N	12	10.3	15	3.9	67	0.8	93
Organic N	2	1.9	3	0.9	54	0.2	91
Ammonium N	10	8.3	17	3.0	70	0.6	94

1. High flow = 41,000 m^3/d (82% of influent flow) through the secondary reed bed and tertiary reed bed.
2. Low flow = 7000 m^3/d (14% of influent flow) through secondary reed bed and tertiary duckweed pond.
3. Low flow w/gravel bed = 2000 m^3/d (4 percent of influent flow) through secondary reed bed and reciprocating gravel bed.
4. Dissolved oxygen is expected to be 2 mg/L in the effluent. Salinity will be transported through the wetland without significant removal. Salinity may actually increase by 10-15 percent due to evapotranspiration.

rates based on the first-order removal models of Kadlec and Knight, 1996, and information provided in WPCF FD-16 (1990). All of the N, and most of the P, is assumed to move through the sediment pond as soluble forms or in association with fine solids that do not settle.

Table I-8. Estimated final water quality

Total BOD mg/L	Total COD mg/L	TSS mg/L	TP mg/L	TN mg/L
< 10	< 40	< 117	< 2.2	< 2.1

3.4 <u>Removal of Heavy Metals by the Treatment System</u>

Heavy metals such as copper, nickel, lead, zinc, chromium, and cadmium are found primarily adsorbed to the sediments in the wastewater. Sedimentation and adsorption of these metals by the wetland plants will be the primary removal mechanism. Benthic and attached forms of algae which are endemic to most emergent wetland systems have been used in Canada and the United States to clean up mining effluents and tailings containing high concentration of heavy metals. Cattail, bulrush, common reeds, and canary grass are capable of absorbing metals from water and sediments and, therefore, will contribute to the treatment system's removal efficiency. In addition, anaerobic conditions that normally prevail near the sediment/water interface will contribute to reduced conditions for precipitation of any dissolved metals as metal sulfides. Thus, there are several metal removal mechanisms in the proposed system which will ensure that the metal concentrations in the water are rapidly reduced before the wastewater flow reaches the duckweed wetland from which plant biomass will be harvested. The following are conservative estimates of metal removal in the treatment system.

Table I-9. Removal of heavy metals by the treatment system. (Based on influent of 50,000 m^3/day)

Metal	Input kg/yr	Sedimentation kg/yr	Harvested kg/yr	Discharged kg/yr	Removal Efficiency %
Copper (Cu)	390	330	42.4	12	97
Nickel (Ni)	236	203	18	13.6	94
Lead (Pb)	250	215	1.5	33	87
Zinc (Zn)	707	607	92	6	99
Chromium(Cr)	463	400	52	13.6	97
Iron (Fe)	96300	91500	5	4795	95
Manganese (Mn)	1490	1400	5	85	94
Mercury (Hg)	8.03	2.06	0	5.97	26
Cadmium (Cd)	886	762	0	124	86

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ANNEX II. WORK SCHEDULE

1.0 CAPACITY BUILDING FOR SUSTAINABLE DEVELOPMENT

1.1 Community Participation
1.2 Capacity Building and Human Resource Development
1.3 Disseminate Wetland Lessons and Experience Gained

2.0 CLEAN WATER, LESS POLLUTION, AND ENHANCED AQUATIC HABITATS AND BIODIVERSITY

2.1 Complete Preconstruction Work for a Demonstration Scale Wetland
2.2 Construction Demonstration Wetland
2.3 Create Opportunities for Sustainable Socioeconomic Growth
2.4 Establish a Monitoring and Evaluation System to Maintain Expected Performance Levels

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ANNEX II WORK SCHEDULE

The proposed work is described in Section D by objective, output, and activity. A summary and schedule for each activity is as follows:

1.0 Capacity Building for Sustainable Development

1.1 Community Participation

Activity 1.1.1 Assist local residents in becoming full partners. Early in the project, the Project Manager will confer with local residents and NGOs to identify those interested in participating in the project. NGOs and local representatives will help organize the entrepreneurial activities associated with planting and harvesting biomass and developing the wetland and aquaculture facilities.

Activity 1.1.2 Involve local residents in human resource and economic development. During the preconstruction phase, the Project Management Team will meet with local residents to identify human resource and economic development opportunities. A working partnership will be maintained to provide local labor and participation in project construction and operation.

Activity 1.1.3 Increase environmental awareness in the local community and Governorate of Port Said. The Project Manager will work with the local media to develop a program of interactive education. Environmental management principles and practice will be conveyed and discussed. The public will be encouraged to participate and suggest how the local community can benefit from the project.

Activity 1.1.4 Assist local participants in business development. Wetland treatment technology will generate a resource-base for sustainable development. Commercial operations will be developed from the aquaculture facilities and biomass produced by the engineered wetland.

Activity 1.1.5 Identify local personnel for wetland construction and operation. The Project Manager will develop specific guidelines to be followed by the construction contractor. The guidelines will be explicitly incorporated into the design and specifications for the project.

1.2 Capacity Building and Human Resource Development

Activity 1.2.1 Identify governmental and academic organizations and personnel and establish communication. The Project Manager and EEAA will identify personnel of various agencies and NGOs that will participate in the oversight, review, and monitoring studies. Relevant agencies may nominate many of these individuals.

1.3 Disseminate Wetland Lessons and Experience Gained

Activity 1.3.1 Prepare and distribute annual reports. Reports will be produced annually on the progress of the project to be distributed to all relevant persons and agencies.

Activity 1.3.2 Prepare and distribute scientific papers. Once the wetland is in operation, scientific papers will be produced using the data collected from the wetland.

Activity 1.3.3 Prepare and distribute socioeconomic results. The project will also generate socioeconomic information related to the improvement of rural water quality, enhancement of human environmental links, development of biomass-based businesses, and the impact on rural families.

In the operation phase, papers and reports will be prepared using the socioeconomic data generated from the wetland.

2.0 Clean Water, Less Pollution, and Enhanced Aquatic Habitats and Biodiversity

2.1 Complete Preconstruction Work for a Demonstration Scale Wetland

Activity 2.1.1 Select project team and initiate preconstruction activities. At the outset of preconstruction, the national Project Management Team members will be hired. The team, under direction of the Project Manager, will solicit proposals and coordinate the selection of a Design and Construction Supervision Contractor.

Activity 2.1.2 Prepare detailed design drawings and specifications. The design contractor will prepare civil, electrical, and mechanical drawings and specifications for tendering, evaluate tenders, award contracts and subcontracts, supervise construction, and ensure that contractors adhere to the plans and specifications.

Activity 2.1.3 Establish project offices and laboratory facilities. Offices will be set up in Cairo and Port Said (and/or the project site) prior to the initiation of preconstruction surveys.

Activity 2.1.4 Tender and award international contract. Once the national team members have been hired, the contract for the international team members will be tendered and awarded.

Activity 2.1.5 Undertake field surveys. Topographic, soil, and hydrogeology surveys will be initiated to define site conditions suitable for engineering design.

Activity 2.1.6 Collect hydrometric and water quality data. Hydrometric and water quality data will be collected to define inflow water characteristics and treatment requirements.

Activity 2.1.7 Prepare and award tenders. The tenders for the wetland construction subcontract will be prepared using design drawings and specifications and the information collected during field surveys.

Activity 2.1.8 Prepare scientific study and monitoring workplans. Define workscope, protocols, and schedules for scientific studies and water quality monitoring of wetland performance. Laboratories will be contracted to conduct specific analyses.

2.2 Construction Demonstration Wetland

Activity 2.2.1 Order hardware. Order all necessary hardware so as to avoid delivery delays to construction.

Activity 2.2.2 Install water intake and pumping station. Install intake manifold and pumps to deliver waters to the wetland system.

Activity 2.2.3 Construct wetlands facilities. After the tendering process is complete, the selected contractor will undertake the construction of the engineered wetland. Labor intensive construction techniques will be used to maximize local employment of unskilled workers.

Activity 2.2.4 Conduct plant procurement/propagation operation. A plant procurement operation or propagation facility will be used to provide the necessary wetland plants. Local residents and plants will be used to the maximum extent feasible.

Activity 2.2.5 Participation by local residents. Hiring for project construction and operation will give priority to local residents. A local labor preference and manual labor premium will be included in all construction and operations.

2.3 Create Opportunities for Sustainable Socioeconomic Growth

Activity 2.3.1 Develop wetland products and markets that will provide jobs, increase local income, and partially offset operating costs. Wetland by-products of commercial value will be produced and market mechanisms developed. To the extent practical, wetland operations will promote local employment, increased incomes, and revenues to offset operating costs.

Activity 2.3.2 Assess environmental and economic improvements and inform local residents. The ability of the wetland technology to increase family income, reduce pollution, and improve Lake water quality will be communicated and demonstrated to local residents. Information will be provided to the local residents through media coverage, site visits, and local programs. The project benefits will be interpreted in terms of increased income to the people, reduced pollution, reduced occurrences of fish contamination, and a more sustainable fishery.

The potential impact on the Lake of expanded use of the wetland technology will be quantified. The long-term environmental and economic benefits will be quantified in terms of Egyptian pounds per cubic meter of clean water produced and the economic worth of the products and labor produced. This will be compared with the costs and benefits of conventional technologies.

2.4 Establish a Monitoring and Evaluation System to Maintain Expected Performance Levels

Activity 2.4.1 Implement the monitoring plans and establish information distribution network on system performance and operation. The Project Manager is responsible for determining the nature and scope of the data to be obtained from the engineered wetland. The Project Manager is also responsible for communicating the performance results to relevant government agencies and developing a system of routine operational procedures.

Activity 2.4.2 System operation to establish operating guidelines. Initial system operations will involve testing of alternative operating methods and procedures. Guidelines will be prepared recommending routine operating procedures.

Table II-1 Schedule of Major Project Outputs

Objective/Output		Year 1		Year 2		Year 3		Year 4		Year 5	
Objective 1—Capacity Building for Sustainable Development											
1.1	Community participation	—	—	—	—	—	—	—	—	—	—
1.2	Capacity building	—	—			—	—	—			
1.3	Dissemination of information		-		-		-		—	—	—
Objective 2—Demonstrate Wetland Technology											
2.1	Preconstruction activities	—	—	—							
2.2	Wetland construction			—	—	—					
2.3	Socioeconomic improvements		—				—	—	—	—	—
2.4	Performance monitoring and operation							—	—	—	—

Table II-2 Schedule by Activity

Output/Activity		Year 1	Year 2	Year 3	Year 4	Year 5
1.1	**Community Participation**					
1.1.1	Develop local partnerships					
1.1.2	Secure local participation in planning, construction, and operation					
1.1.3	Increase environmental awareness					
1.1.4	Develop local businesses					
1.1.5	Utilize local labor force					
1.2	**Capacity Building**					
1.2.1	Governmental and academic participation					
1.3	**Technology Transfer**					
1.3.1	Prepare and distribute annual reports					
1.3.2	Prepare and distribute scientific papers					
1.3.3	Prepare and distribute socio-economic results					
2.1	**Preconstruction work**					
2.1.1	Select project team and initiate design activities					
2.1.2	Design and supervision					
2.1.3	Establish offices					
2.1.4	Secure international team					
2.1.5	Conduct field surveys					
2.1.6	Collect water resource data					
2.1.7	Prepare and award construction tenders					
2.1.8	Prepare scientific study and monitoring workplans					
2.2	**Wetland Construction**					
2.2.1	Order hardware					
2.2.2	Install water intake and pumps					
2.2.3	Construct wetland facilities					
2.2.4	Conduct plant procurement/ propagation operation					
2.2.5	Local participation in construction and operation					
2.3	**Socioeconomic Opportunities**					
2.3.1	Develop products and markets					
2.3.2	Assess improvements					
2.4	**Operation and Monitoring**					
2.4.1	Performance monitoring					
2.4.2	Operating guidelines					

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ANNEX III. PROJECT REVIEW, REPORTING, AND EVALUATION PLAN

1.0 TRIPARTITE REVIEWS AND REPORTS

2.0 INDEPENDENT ANNUAL REVIEW

3.0 ANNUAL REPORTS

4.0 TERMINAL REVIEW AND REPORT

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ANNEX III PROJECT REVIEW, REPORTING, AND EVALUATION PLAN

Table III-1 provides a schedule for the following project review and evaluation activities.

1.0 Tripartite Reviews and Reports

In the 10th month of each of the first four years, a Project Performance Evaluation Report (PPER) will be prepared by the Project Manager, reviewed by the Project Management Board, and submitted to the UNDP. The PPER will review the activities and outputs in the context of the entire project schedule. In the 12th month of each of the first four years, the UNDP, the Executing Agency and the Government representatives will meet to review the PPER.

2.0 Independent Annual Review

Every 12 months the International Consultant will conduct an independent review of the project's progress and submit a summary report to the Project Management Board, UNDP and the Executing Agency.

3.0 Annual Reports

Each year, an Annual Report will be prepared by the Project Manager. The report will summarize the progress of the project, results of the monitoring and academic research programs, system performance, local participation, and expenditures. The report will be distributed to relevant government departments, research institutions, and donor agencies.

4.0 Terminal Review and Report

In the 8th month of the final year, the Terminal Report will be submitted (the final PPER). In the 10th month of the final year, the UNDP, Executing Agency, and Government representatives will meet to review the Terminal Report for the project.

Table III-1 Project review, report, and evaluation.

Activity	Year 1				Year 2				Year 3				Year 4				Year 5			
Project Performance Evaluation Reports (PPER) and Tripartite Review				—				—				—				—				—
Independent Annual Review and Summary Reports				—				—				—				—				—
Annual Project Reports				—				—				—				—				—
Midterm Evaluation										—	—									
Terminal Review and Report																			—	—

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ANNEX IV. PRELIMINARY DESIGN CALCULATIONS AND CONSTRUCTION COST ESTIMATES

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ANNEX IV. PRELIMINARY DESIGN CALCULATIONS AND CONSTRUCTION COST ESTIMATES

1.0 Introduction

The engineered wetland treatment system includes wastewater withdrawal, pumping, treatment, and discharge of the treated effluent. The function of each major component of the system is discussed in Annex I. This annex presents preliminary design parameters for the following components:

A. Intake structure for pumping water from the Bahr El Baqar drain, including intake manifold, wetwell, and pump house.
B. Sedimentation basin.
C. Secondary treatment emergent plant wetlands.
D. Three tertiary treatment wetlands consisting of 1) emergent plant wetlands, 2) floating plant wetlands, and 3) reciprocating wetlands.
E. Aquaculture facility.
F. Drying beds.

Basic site conditions for the system are given in Table IV-1. The following sections describe preliminary design criteria and variables. Changes will be made as necessary during the detailed design phase to accommodate site conditions, equipment requirements, and cost considerations. Detailed specifications will be developed for critical project elements, such as grading plans, liners to control seepage, and flow measuring and control devices. The project scale and cost are extremely sensitive to site conditions, particularly ground elevation. If a site is not available that meets the assumed elevation above groundwater (i.e., 1 meter), a reduction in project scale may be necessary.[*]

Detailed design drawings and specifications will be prepared under a subcontract. The Design Contractor will design and coordinate site surveys; prepare civil, electrical, and mechanical drawings and specifications for tendering; evaluate tenders; award contracts and subcontracts; supervise construction; and ensure that contractors adhere to the plans and specifications. If necessary, a separate contract may be developed during the operational phase of the project for minor design modifications.

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[*] Actual treatment capacity could be less than 50,000 m^3/day if the ground elevation of the project site requires excessive fill and/or dewatering. All subsequent preliminary design calculations and cost estimates in the document are based on a site elevation of 1 meter above the normal groundwater level and a treatment capacity of 50,000 m^3/day.

Table IV-1. Characteristics of the project site.

Parameter	Units	Value
Total wetland system area	feddans	120
Future expansion area	feddans	80
Design flow rate	m^3/d	50,000*
Average lake surface elevation	m, msl	0
Average ground surface elevation	m, msl	1
Average depth to groundwater	m	1
Average drain depth	m	3
Average drain flow rate	m^3/d	3×10^6

2.0 Wastewater Intake

2.1 Intake Structure

The intake structure from the Bahr El Baqar drain will be designed to withdraw flow from the drain to the pumping station. Offsetting the pumping to a side channel will minimize potential sediment problems that may result from in-channel pumping. The wastewater intake will be designed for flow velocities of less than 0.4 m/s to minimize the uptake of sediment. The intake structure will be screened to avoid transport of large objects. A trash rack screen may be used to trap large debris (e.g., openings 38 to 150 mm). The trash rack will be followed by a coarse screen to remove solids about half the size of the largest material that can be pumped (typically 25 to 50 mm). The approach to the screens will be straight to ensure good velocity distribution. Velocities through the manually cleaned screens will be 0.3 to 0.6 m/s.

The flow velocities in the pipes or channel transporting influent wastewater from the drain to the pumping sump will be greater than 0.8 m/s to keep suspended solids in solution and avoid accumulation in the transfer lines.

Wetwell water levels for optimum pump operation will comply with equipment manufacturer's recommendations.

2.2 Pumping Station

A reinforced concrete building will be constructed to house the pumps and mechanical, electrical, and civil appurtenances. Influent wastewater will be pumped with centrifugal, screw, or similar pumps suited for low lift, high capacity, and nonclog service. The pumps will be high efficiency and relatively simple in design and operation to minimize pumping costs and maintenance requirements. A separate system for pump cooling is not anticipated. At least two

* Actual treatment capacity could be less than 50,000 m^3/day if the ground elevation of the project site requires excessive fill and/or dewatering. All subsequent preliminary design calculations and cost estimates in the document are based on a site elevation of 1 meter above the normal groundwater level and a treatment capacity of 50,000 m^3/day.

parallel pumps will be used to provide full standby and backup capacity. Long-term reliability and maintenance will be key considerations. The pumping conditions are summarized in Table IV-2.

Table IV-2. Approximate intake pumping conditions.

Parameter	Units	Value
Average daily flow rate	m^3/s	0.58
Pumping head	m	3-5
Pumping efficiency	%	70
Annual power use	kWh	284,000
2-Pump capacity	hp	50/pump
3-Pump capacity	hp	25/pump

3.0 Sedimentation Basin

The sedimentation basin is assumed to be rectangular. The final shape and configuration will be determined during the design phase based on site conditions and cost considerations. Separate cells will be used as needed to facilitate settling, control dredging disturbances, and prevent short circuiting. Table IV-3 shows the parameters and values for the sizing of the sedimentation basin:

Table IV-3. Preliminary design parameters for sedimentation basin.*

Parameter	Units	Value
Average flow rate	m^3/d	50,000
Retention time	days	2
Total depth	m	3
Operating depth	m	2
Volume of water	m^3	100,000
Area	m^2	50,000
Length	m	440
Width	m	114
Side slope		3.5:1
Bottom slope	%	0
Freeboard	m	1

*Liner specifications will be developed based on site conditions and allowable leakage.

The following equation estimates the width of the intake weir for the sedimentation basin:

$$\mathbf{Q = 2/3\ C_d\ B\ 2^{1/2}\ g\ H^{3/2}}$$

where, Q = Discharge, m^3/s
Cd = Discharge coefficient
B = Width of the weir, m
g = Gravity acceleration, m/s^2
H = Head above weir crest, m

if Q = $0.58\ m^3/s$
Cd = 0.65
g = $9.81\ m/s^2$
h = 0.25

then B = 2.4 m or approximately 3 m

4.0 Secondary Treatment Wetlands

Wastewater will move from the sedimentation basin to the secondary treatment cells (Figure I-2). Water will enter the secondary treatment reed beds through a header system spaced over the width of each cell. The header system should achieve uniform flow distribution across the width of the cells. A section of limestone will be placed beneath the flow distribution system to help equalize flow.

Table IV-4 shows the parameters used preliminary sizing of the two emergent plant wetlands:

Table IV-4. Preliminary design parameters for secondary treatment cells.

Parameter	Units	Value
Flow rate*	m^3/d	41,000 and 9,000
Hydraulic loading rate*	m/d	0.55 and 0.12
Retention time*	d	0.9 and 4.2
Outlet water depth	m	0.5
Inlet water depth for high-flow wetland	m (see below)	0.6
Inlet water depth for low-flow wetland	m (see below)	0.54
Volume of water per cell	m^3	37,500
Surface area per cell	m^2	75,000
Length	m	375
Width	m	200
Aspect ratio (length/width)	-	1.87
Berm side slope	-	3.5:1
Bottom slope	%	0
Freeboard	m	1

* The high-flow emergent wetland will be operated at 0.9 d retention time with a flow rate and loading rate of 41,000 m^3/d and 0.55 m/d, respectively. The low-flow emergent wetland will be operated at 4.2 d retention time with a flow rate and loading rate of 9000 m^3/d and 0.12 m/d, respectively.

The hydraulic design will take into account the resistance offered by the vegetation in each wetland cell. The frictional resistance is a function of plant density, plant stem volume, and depth of flow. For densely vegetated wetlands, Manning's frictional coefficient "a" is $1x10^7 m^{-1} d^{-1}$ (Kadlec and Knight, 1996).

A modified Manning equation for wetlands can be used to calculate the head required to maintain a 9000 m^3/d (low-flow wetland) or 41,000 m^3/d (high-flow wetland) flow. The equation as presented in Kadlec and Knight (1996, p.204) is:

$$\mathbf{M_1 = q\ L^2 / ah_o^4 = y^3\ (-dy/dz - S1)}$$

where **q** is the hydraulic loading rage in m/d, **L** is the wetland length in m, **a** is a friction coefficient equal to $1 \times 10^7\ d^{-1}\ m^{-1}$, $\mathbf{h_o}$ is the water depth at outlet in m, **z** is fractional distance along the length of the wetland, $\mathbf{y = h/h_o}$ where **h** is water depth at **z**, and **S1** is proportional to the bottom slope. Using a bottom slope of zero, the equation becomes:

$$\mathbf{M_1 = q\ L^2 / ah_o^4 = y^3\ (-dy/dz)}$$

M1 can be determined from design parameters and integration of the above equation yields the ratio of inlet water depth to outlet water depth (RATIO = h_i/h_o) for a given M1. The inlet water depth is determined as:

$\mathbf{h_i = RATIO\ (h_o)}$
required head difference = $\mathbf{h_i - h_o}$

For the emergent wetland at high-flow and low retention time, the following parameters apply:

q = 0.55 m/d, L = 375 m, and $\mathbf{h_o = 0.5}$ **m**

Therefore, M1 = 0.124. From Fig. 9-14 in Kadlec and Knight (1996), RATIO = 1.2. The required head difference is then 10 cm.

For the emergent wetland at low-flow and high retention time, the following parameters apply:

q = 0.12 m/d, L = 375 m, and $\mathbf{h_o = 0.5}$ **m**

Therefore, M1 = 0.027. From Fig. 9-14 in Kadlec and Knight (1996), RATIO = 1.08. The required head difference is then 4 cm.

Every 125 m in the wetlands, a deep open channel will be incorporated to evenly distribute water flow across the width of the wetland. The channels will have 1 m water depth and will be 4 m long. A deep open channel will also be placed at the end of each wetland to collect water before being discharged into three concrete sumps. Water flow into the sumps will be controlled by adjustable weirs.

5.0 Tertiary Treatment Wetlands

Three types of tertiary treatment wetlands will be employed in the project: an emergent plant wetland, a floating plant wetland using duckweed as the floating plant, and a gravel-based wetland with reciprocation to promote aerobic treatment. The tertiary emergent plant wetland will receive water from the high-flow secondary emergent plant wetland. The floating plant wetland and reciprocating wetland will receive water from the low-flow secondary emergent plant wetland. The flow of water from the secondary to tertiary wetlands as just described is the proposed method of operation. This operation mode provides three treatment options that treat the water to varying degrees (see Annex I). Flexibility will be incorporated to provide options to direct water from the secondary wetlands to the tertiary wetlands in any combination desired.

Water will be delivered into the tertiary wetlands through a header system spaced over the width of the wetland. Water will be discharged into a section of limestone rock to help equalize flow before being released to the wetland cells.

5.1 Emergent Plant Wetland

Table IV-5 shows the preliminary design parameters for the tertiary emergent plant wetland:

Table IV-5. Preliminary design parameters for tertiary emergent wetland.

Parameter	Units	Value
Flow rate	m^3/d	41,000
Hydraulic loading rate	m/d	0.82
Retention time	d	0.6
Outlet water depth	m	0.5
Inlet water depth	m (see below)	0.63
Volume of water	m^3	25,000
Surface area	m^2	50,000
Length	m	375
width	m	133
Aspect ratio (length/width)	-	2.8
Berm side slope	-	3.5:1
Bottom slope	%	0
Freeboard	m	1

For the emergent wetland the following parameters apply for the modified Manning equation for wetlands:

$q = 0.82$ m/d, $L = 375$ m, and $h_o = 0.5$ m

Therefore, M1 = 0.184. From Fig. 9-14 in Kadlec and Knight (1996), RATIO = 1.25. The required head difference is then 13 cm.

5.2 Floating Plant Wetland

Table IV-6 shows the preliminary design parameters for the tertiary floating plant wetland:

Table IV-6. Preliminary design parameters for tertiary floating plant wetland.

Parameter	Units	Value
Flow rate	m^3/d	7,000
Hydraulic loading rate	m/d	0.14
Retention time	d	3.6
Outlet water depth	m	0.5
Inlet water depth	m (see below)	0.55
Volume of water	m^3	25,000
Surface area	m^2	50,000
Length	m	375
Width	m	133
Aspect ratio (length/width)	-	2.8
Berm side slope	-	3.5:1
Bottom slope	%	0
Freeboard	m	1

For the floating plant wetland the following parameters apply for the modified Manning equation for wetlands:

q = 0.14 m/d, L = 375 m, and h_o = 0.5 m

Therefore, M1 = 0.032. From Fig. 9-14 in Kadlec and Knight (1996), RATIO = 1.1. The required head difference is then 5 cm.

Duckweed will be used as the floating plant. Because of duckweed's high protein content, the plant is valuable as a source of fish feed in addition to providing nutrient removal in the wastewater. To avoid duckweed from accumulating on one side of the wetland or another from wind action, open water sections will be created with borders of canarygrass or another clump-forming wetland species. Each section will be approximately 50 m long and 10 m wide.

5.3 Reciprocating Wetland

Reciprocating wetlands will consist of two subsurface flow wetland cells sitting side by side. Water will flow through gravel placed into the cells with an approximate porosity of 40 percent. This type of wetland is referred to as reciprocating because water is continuously transferred from one cell to another via pumps. The periodic movement of water out of the gravel allows for

the substrate to become easily aerated via oxygen diffusion in air. The oxygenation of the biofilms on the gravel surface allows for culturing aerobic bacteria which aid in the removal of BOD and ammonium-N. Because of the continuous reciprocation, the retention volume in the gravel bed is not equal to the total available porosity volume. The design calculations assume the retention volume is equal to the porosity volume for one cell in the pair and one-third the porosity volume in the other cell of the pair.
Table IV-7 shows the preliminary design parameters for the tertiary reciprocating wetland:

Table IV-7. Preliminary design parameters for tertiary reciprocating wetland.

Parameter	Units	Value
Flow rate	m^3/d	2,000
Hydraulic loading rate	m/d	0.2
Retention time	d	2
Outlet water depth	m	1
Inlet water depth	m (see below)	1.11
Volume of water	m^3	4,000
Surface area	m^2	15,000
Length	m	110
Width	m	140
Aspect ratio (length/width)	-	0.56
Berm side slope	-	3.5:1
Bottom slope	%	0
Freeboard	m	1

For subsurface-flow wetlands, head loss requirement is determined differently from surface-flow wetlands. The important parameters for determining head loss (Kadlec and Knight, 1996) are:

L = 75 m, gravel porosity (e) = 0.4, detention time (t) = 2 d

The superficial velocity, u, equals L e / t which is 15 m/d. Assuming a gravel hydraulic conductivity of 10,500 m/d (k_e) yields a meter head loss per meter wetland length as:

$dH/dx = -u/k_e = -15 / 10{,}500 = -0.00143$.

For a 75 m wetland length, the required head loss is 0.00143(75) = 0.11 m or 11 cm.

5.4 Discharge of Water from Tertiary Wetlands

Water released from the reciprocating gravel-bed wetlands will be used to raise fish in an aquaculture facility. Water will be released to a series of small and large ponds. Water from the aquaculture ponds, emergent wetland, and floating plant wetland will leave the systems via weirs so water flow rates can be monitored. Three weirs will be positioned evenly across the widths of the tertiary emergent wetland and floating plant wetland to ensure even distribution of water flow rates at the end of the wetlands. The water will drain into open channels that will direct water to a common open channel directing water to Lake Manzala or back into Bahr El Baqar drain.

6.0 Aquaculture Facility

Table IV-8 shows the preliminary design parameters for the aquaculture facility hatchery ponds. The design is for an individual pond; however, there will be four such ponds in the proposed hatchery facility, each with independent water inlets and outlets.

Table IV-8. Preliminary design parameters for the hatchery ponds.

Parameter	Units	Value
Flow rate	m^3/d	50
Retention time	d	15
Outlet water depth	m	1
Inlet water depth	m (see below)	0.5
Volume of water	m^3	750
Surface area	m^2	1000
Length	m	50
Width	m	20
Aspect ratio (length/width)	-	2.5:1
Berm side slope	-	3.5:1
Bottom slope	%	1
Freeboard	m	0.5

The head difference requirement between the inlet and outlet is assumed to be negligible. The inlet water depth is less than the outlet water depth due to a bottom slope of 1 percent.

Table IV-9 shows the preliminary design parameters for the aquaculture facility fingerling ponds. The design is for an individual pond; however, there will be two such ponds in the proposed hatchery facility, each with independent water inlets and outlets.

Table IV-9. Preliminary design parameters for the fingerling ponds.

Parameter	Units	Value
Flow rate	m^3/d	900
Retention time	d	10
Outlet water depth	m	1
Inlet water depth	m	0.8
Volume of water	m^3	9,000
Surface area	m^2	10,000
Length	m	200
Width	m	50
Aspect ratio (length/width)	-	4.0:1.0
Berm side slope	-	3.5:1
Bottom slope	%	0.1
Freeboard	m	0.5

The head difference requirement between the inlet and outlet is assumed to be negligible. The inlet water depth is less than the outlet water depth due to a bottom slope of 0.1 percent.

The aquaculture facility will be based on labor intensive hatchery technology with the intention of producing several million Lake Manzala strain tilapia, *Oreochromis niloticus*, which can be either sold to the existing aquaculture industry or used for the replenishment of Lake Manzala, which is heavily fished on an annual basis.

Plans are to install four 0.1 ha breeding ponds, which will be stocked with Lake Manzala stain tilapia broodstock (200-500 g each) at a density of 1 fish/m^2, and at a sex ratio of 1 male to 1 female (1:1). Fish will be fed at approximately 0.5 to 1.0 of body weight per day using a combination of prepared fish feed (pellets) and/or duckweed. The import of N via fish feed pellets is anticipated to result in only a minor increase in NH_4-N concentration in the water (approximately 0.2 mg/L). It is anticipated that under proper management, it should be possible to produce several million fry per year. Fry collected from the hatchery ponds will be subsequently stocked into the fingerling production ponds at high density (1-2 million/ha), and cultured for an additional 30 days prior to harvesting and marketing approximately ten such cycles per year.

In the case where fingerlings will be sold to other aquaculture interests, the fry will be sex-reversed to all-male populations by feeding the sexually undifferentiated fry a feed additive (methyltestosterone). This procedure will enable farmers to raise the faster growing males to market size and eliminate the overpopulation problems that are unavoidable in mixed-sex populations.

For purposes of restocking to augment Lake Manzala, the fry will not be sex-reversed, so that normal breeding populations can be sustained.

7.0 Drying Beds

Drying Beds will be used for drying sediment sludge from sedimentation basin and also the harvested plants from the wetland channels. The sludge drying beds will be designed in accordance with standard practices and expected characteristics of the sediment/sludge. Drainage waters will be collected and directed back to the sedimentation basin. The dried sediment will be tested for contaminants and, if suitable, used for construction or fill material.

Table IV-10. Preliminary design parameters for sludge drying beds.

Parameter	Units	Value
Estimated amount of sediment sludge	tons/day	4
Number of sediment drying beds	beds	4
Area of each sediment drying bed	m^2	1000 (40 x 25 m)
Depth of sediment drying bed	m	0.3
Total volume of harvested plants	tons/day	2
Number of plant drying beds	beds	2
Area of each plant drying bed	m^2	400 (40 x 25 m)
Depth of plant drying bed	m	0.3

8.0 Water Distribution Structures

Water collection and distribution channels will be provided for each wetland system component. Water flow between cells will be accomplished and controlled with portable gravity pipes and valves.

9.0 Preliminary Cost Estimates

The following sections provide preliminary cost estimates for each component of the wetland treatment system. The estimates are based on initial assumptions regarding site conditions, unit costs, and design parameters. All estimates will be upgraded during the design phase, based on actual site conditions, project design, and current costs.

9.1 Intake and Pumping Station

Based on several large pumping stations constructed in Egypt before 1986, the following cost equation relates pumping head and pumping flow to the price of all civil , mechanical, and electrical and intake works, is:

$$\textbf{Cost (100 L.E.)} = [(3.22\,H + 23.8)\,Q]\,C_1\,C_2$$

Where,

H	**= manometric head in meters**
Q	**= total flow rate in m^3/s**
C_1	**= inflation factor**
C_2	**= currency correction factor, which is the ratio of the current U.S. dollar value to its value in 1986 (1986: 1 US$ = 1.3 LE)**

For the project pumping station,

Q	**= 0.58 m^3/s**
H	**= 6 m**
C_1	**= $(1.1)^{11}$**

$$C_2 = \frac{3.34 \text{ (1996 value)}}{1.3 \text{ (1986 value)}} = 2.57$$

Estimated Cost = [(3.22 x 5 + 23.8) 0.58] (2.85) (2.57)
= 183,000 L.E.

An additional 230 percent premium for the small size of pumping station and remote location results in an estimated total cost of 600,000 L.E. or $ 180,000 U.S.D.

Summary:

Total Estimated Cost = 600,000 L.E.
= $180,000 U.S.D.

9.2 Sedimentation Basin

Bottom Excavation

Surface Area	= 440 m x 114 m	=	50,160 m^2
Excavation Depth	= 1.0 m		
Volume to be Excavated	= 50,160 m^2 x 1.0 m	=	50,160 m^3
Estimated Cost (incl. seal)	= 50,160 m^3 x 8.0 L.E.	=	400,000 L.E.

Dike Construction

Height of Dike	= 3.0 m		
Cross-section Area	= (10.5 x 3.0) + 3.0 x 3.0	=	40.5 m^2
Volume of Fill	= 40.5 m^2 x (450 + 124) x 2	=	46,000 m^3
Estimated Cost (incl. seal)	= 46,000 m^3 x 6.0 L.E.	=	280,000 L.E.

Short Circuiting Barrier

Length	= 1320 m		
Estimated Cost	= 1320 m x 15.0 L.E.	=	20,000 L.E.

Summary

Total Estimated Cost	= 400,000 + 280,000 + 20,000	=	700,000 L.E.
	= $ 210,000 U.S.D.		

9.3 Secondary Treatment Wetlands

Bottom Cut and Fill

Surface Area	= 150,000		
Depth of Cut and Fill	= 0.2 mm		
Volume Cut and Fill	= 0.2 m x 150,000 m^2	=	30,000 m^3
Estimated Cost (incl. seal)	= 30,000 m^3 x 8.0 L.E.	=	240,000 L.E.

Dike Construction

Height of Dike	= 1.7 m		
Cross-section Area	= (1.7 x 6.0) + (3.0 x 1.7)	=	15.3 m^2
Volume of Fill	= 15.3 m^2 x (343 + 235) x 2	=	18,000 m^3
Estimated Cost (incl. seal)	= 18,000 m^3 x 6.0 L.E.	=	110,000 L.E.

Reed Bed Planting and Development

Surface Area	= 150,000 m^2		
Estimated Cost	= 150,000 m^2 x 1.2 L.E.	=	180,000 L.E.

Summary

Total Estimated Cost	= 240,000 + 110,000 + 180,000	=	530,000 L.E.
	= $ 160,000 U.S.D		

9.4 Tertiary Treatment Wetlands

Bottom Excavation

Surface Area	= (50,000 +50,000 +10,000)	=	110,000 m^2
Excavation Depth	= 0.6 m		
Volume to be Excavated	= 0.6 m x 110,000 m^2	=	66,000 m^3
Estimated Cost (incl. seal)	= 66,000 m^3 x 7.0 L.E.	=	460,000 L.E.

Dike Construction

Height of Dike	= 1.0 m		
Cross-section Area	= (3.5 x 1.0) + (3.0 x 1.0)	=	6.5 m^2
Volume of Fill	= 6.5 m^2 x (343 + 160) x 4 + (77 +160) x 2		
	= 96,000 m^3		
Estimated Cost (incl. seal)	= 96,000 m^3 x 6.0 L.E.	=	60,000 L.E.

Wetland Planting and Development

Surface Area	= 110,000 m^2		
Estimated Cost	= 110,000 m^2 x 1.2 L.E.	=	130,000 L.E.

Reciprocating System Development

Wetland Gravel Cost	= 10,000 m^2 x 1.0 m x 30 L.E.	=	300,000 L.E.
Pump and Appurtenances Cost	= 50,000 L.E.		

Summary

Total Estimated Cost	= 460,000 + 60,000 + 130,000 + 300,000
	= 950,000 L.E.
	= $ 330,000 U.S.D

9.5 Aquaculture Facility

Bottom Excavation

Surface Area	= (10,000 + 10,000 + 4000)	=	24,000 m^2
Average Depth of Cut	= 0.7 m		
Volume of Cut	= .7 x 24,000 m^2	=	16,800 m^3
Estimated Cost (incl. seal)	= 16,800 m^3 x 8.0 L.E.	=	130,000 L.E.

Dike Construction

Height of Dike	= 1.0 m		
Cross-section Area	= (3.5 x 1.0) + (3.0 x 1.0)	=	6.5 m^2
Volume of Fill	= 6.5 m^2 x (160 + 77) x 4 + (35 +35) x 8		
	= 9800 m^3		
Estimated Cost (incl. seal)	= 9800 m^3 x 6.0 L.E.	=	60,000 L.E.
Miscellaneous Small Equipment	= 100,000 L.E.		

Summary

Total Estimated Cost	= 130,000 + 60,000 + 100,000	=	290,000 L.E.

= 90,000 U.S.D.

9.6 Support Facilities and Other Costs

Site Fill and Dewatering Contingency	=	900,000 L.E.
Drying Beds (2400 m^2 x 21.0 L.E.)	=	140,000
Laboratory and Maintenance Buildings (200 m^2 x 1500 L.E.)	=	300,000
Discharge (1500 m x 40 L.E.)	=	60,000
Water Distribution Flow Control	=	500,000
Access Roads (on-site)	=	400,000
Utilities (on-site)	=	250,000
Innovative Technologies	=	100,000
Manual Labor Premium	=	100,000
		2,750,000 L.E.
Total Other Costs		$ 820,000 U.S.D.

9.7 Summary of Cost Estimates

Table IV-9. Summary of preliminary construction costs.

Item	Unit	Quantity	Unit Cost (L.E.)	Estimated Total Cost (L.E).	Estimated Total Cost ($U.S.)
Intake and Pumping Station	Ea.	1	L.S.	600,000	$ 180,000
Sedimentation basin					
Bottom Excavation	m^3	50,000	8.0	400,000	120,000
Dike Construction	m^3	46,500	6.0	280,000	80,000
Short-circuiting Barrier	m	1,320	15.0	20,000	10,000
Subtotal				700,000	210,000
Secondary Treatment Wetlands					
Bottom Cut and Fill	m^3	30,000	8.0	240,000	70,000
Dike Construction	m^3	18,000	6.0	110,000	30,000
Reed Bed Planting and Development	m^2	150,000	1.2	180,000	60,000
Subtotal				530,000	160,000
Tertiary Treatment Wetlands					
Bottom Excavation	m^3	66,000	7.0	460,000	140,000
Dike Construction	m^3	9,600	6.0	60,000	20,000
Wetland Planting and Development	m^2	110,000	1.2	130,000	40,000
Gravel Bed	m^2	10,000	30.0	300,000	90,000
Reciprocating Pump System	Ea.	1	L.S.	50,000	10,000
Subtotal				1,000,000	300,000
Aquaculture Facility					
Bottom Excavation	m^3	15,600	8.0	130,000	40,000
Dike Construction	m^3	9,800	6.0	60,000	20,000
Miscellaneous			L.S.	100,000	30,000
Subtotal				290,000	90,000
Site Preparation/Support Facilities					
Fill and Dewatering Contingency			L.S.	900,000	270,000
Drying Beds	m^2	6,000	24.0	140,000	40,000
Laboratory Maintenance Building	m^2	200	1500.0	300,000	90,000
Discharge	m	1500	40.0	60,000	20,000
Water Distribution and Flow Control			L.S.	500,000	150,000
Access Roads (on-site)			L.S.	400,000	120,000
Utilities (on-site)			L.S.	250,000	70,000
Innovative Technologies			L.S.	100,000	30,000
Manual Labor Premium			L.S.	100,000	30,000
Subtotal				2,750,000	820,000
Total				5,870,000	1,760,000
Contingency				700,000	210,000
Total Construction Cost				6,570,000	$1,970,000

10.0 Unit Price Estimates

The range of 1996 unit prices for selected project components is given in Table IV-12. Cost estimates will be revised during the design phase based on site conditions, economic considerations, and final design requirements.

Table IV-12. Unit price estimates for 1997.

Item	Unit	Unit Price (L.E.)
Removal and disposal of topsoil (depth 0.3 m)	m^2	1.0
Excavation for pond and distribution channel	m^3	4.0-6.0
Placing and compacting clay in embankments	m^3	5.0-8.0
Placing and compacting borrow material in embankments	m^3	5.0
Supply of borrow material to site	m^3	6.0-8.0
Excavation and backfill for inlet and outlet works	m^3	3.0-6.0
Disposal of excess material (clay)	m^3	30-5.0
Pitrun Gravel (0.3 m) for access road including transfer and compaction	m^2	9.0-15.0
Plain concrete	m^3	200.0
Reinforced concrete (substructures) including framework	m^3	500.0-600.0
Reinforced concrete (superstructures) including framework	m^3	550-600
Stone pitching (0.4 m thick)	m^3	30.0-80.0
Gates (wooden planks in guide rails)	m^2	2500-4000
Contractor’s insurance, fees, etc.	%	5.0

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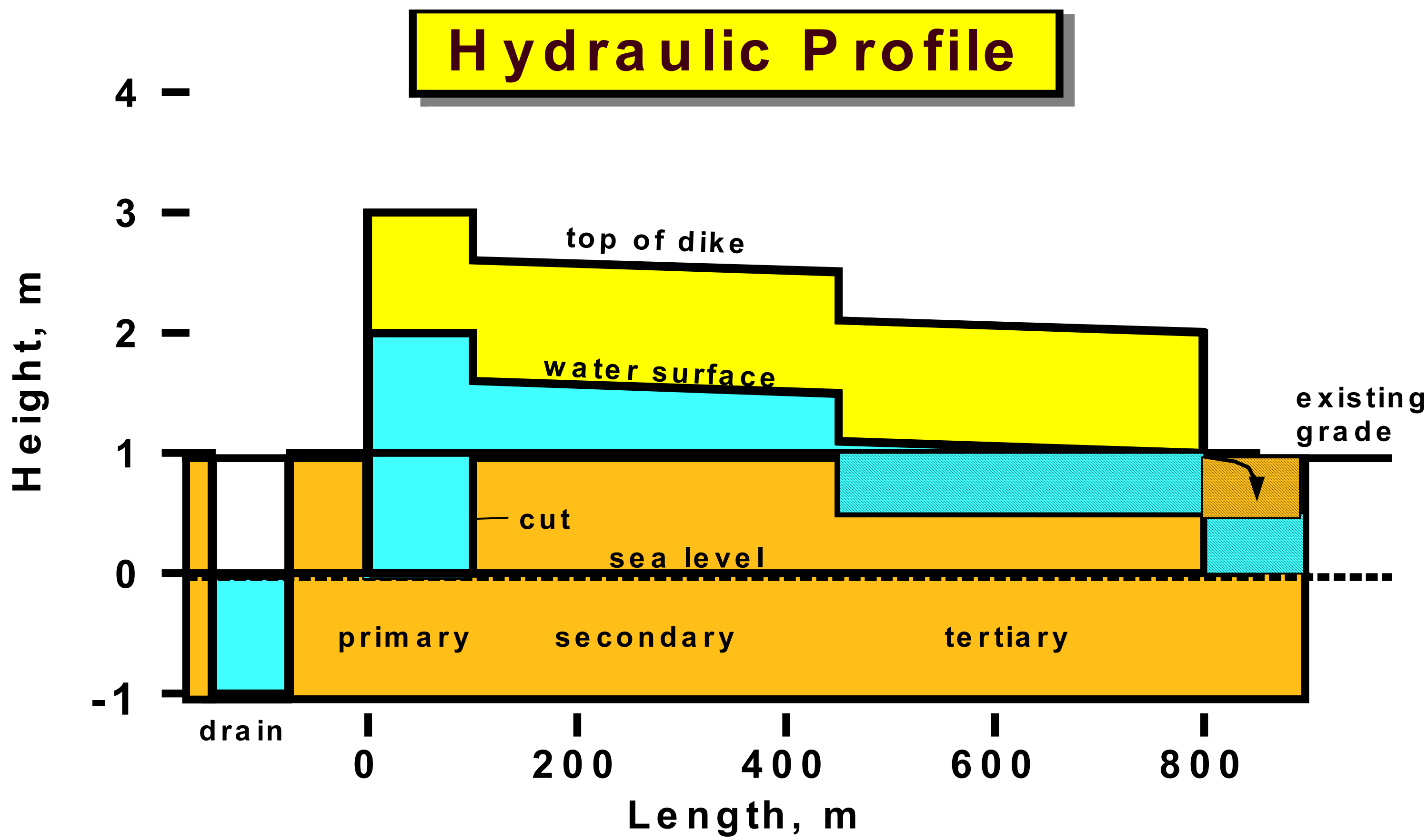

Figure IV-1. Preliminary hydraulic profile of treatment wetlands.

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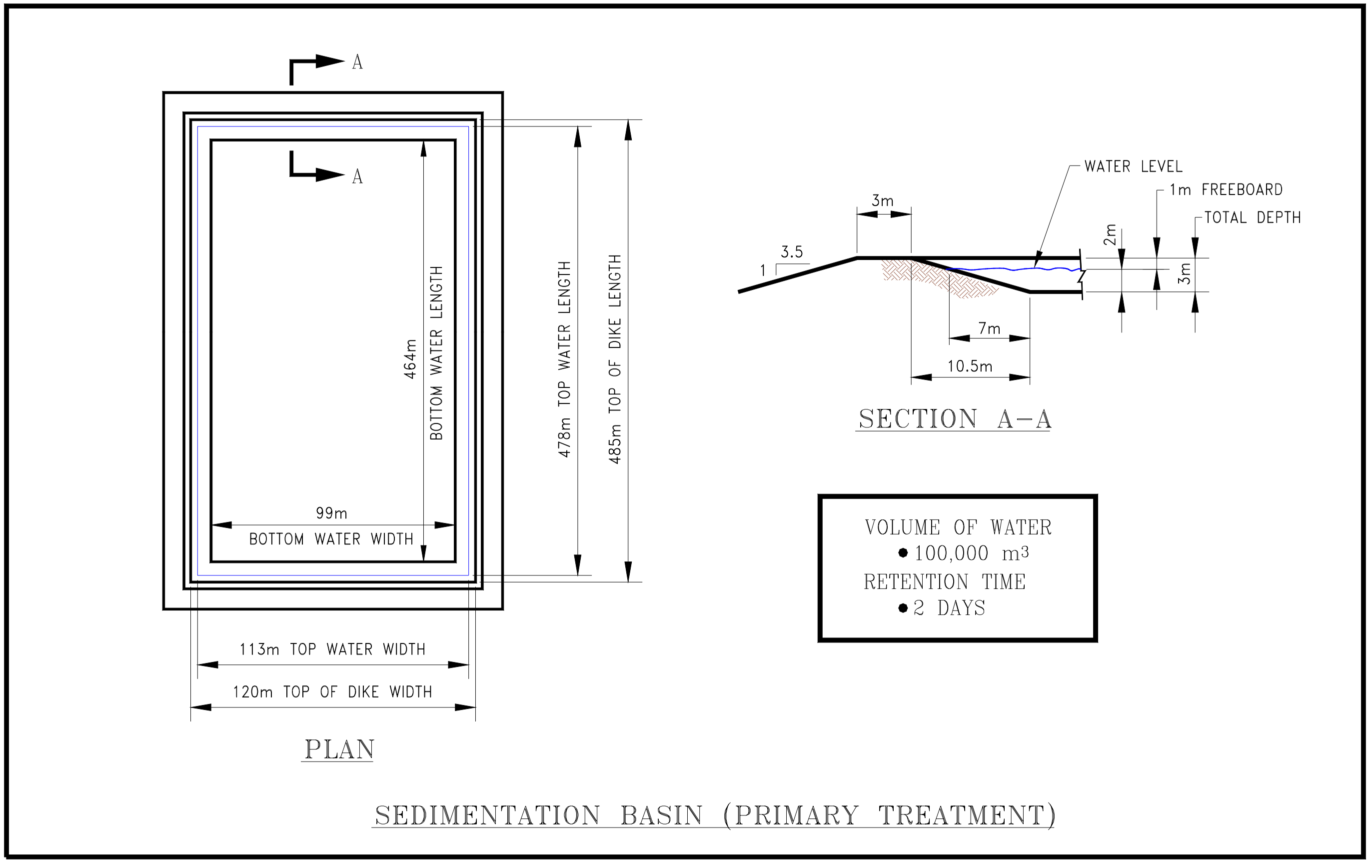

Figure IV-2. Preliminary layout of sedimentation basin.

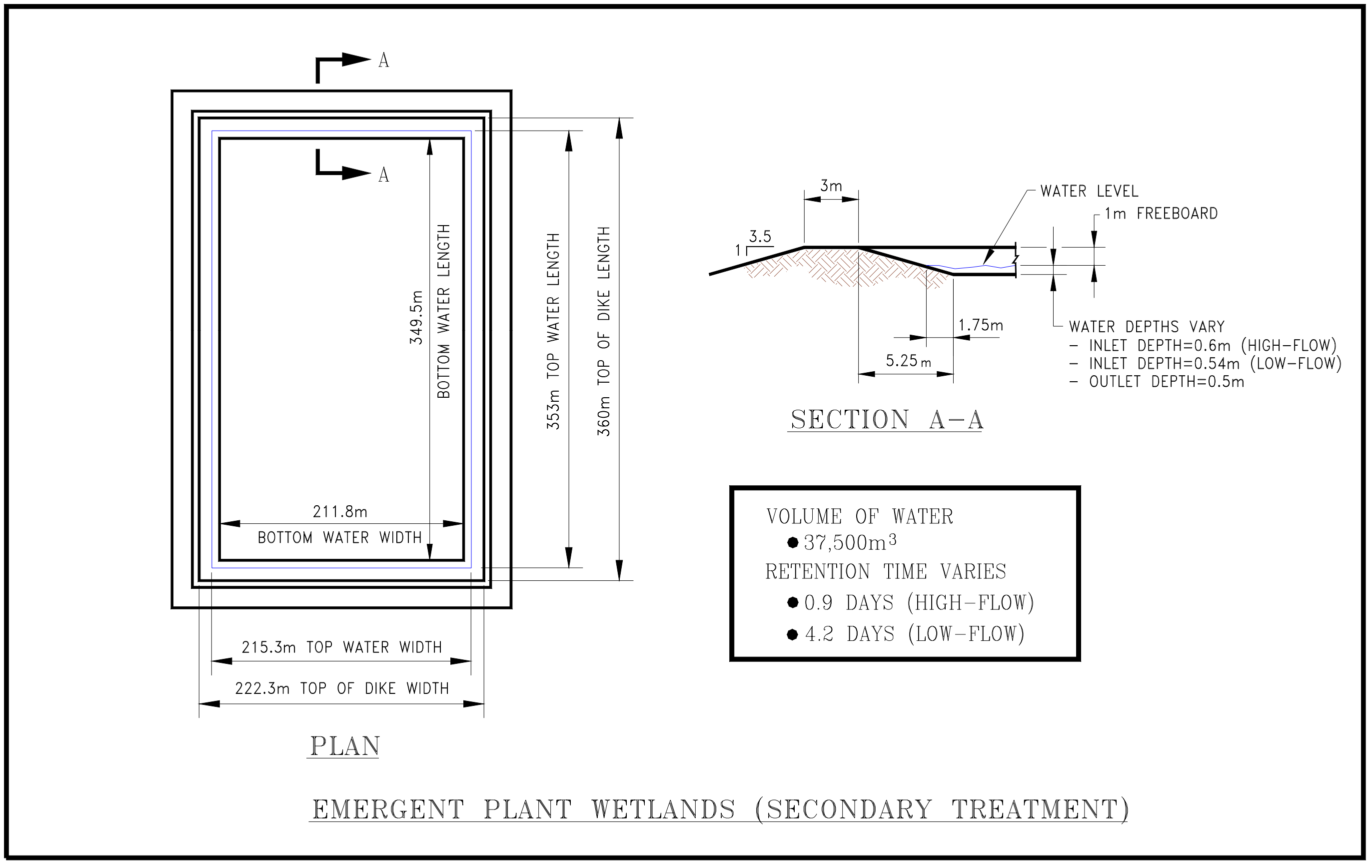

Figure IV-3. Preliminary layout of emergent plant wetlands as secondary treatment.

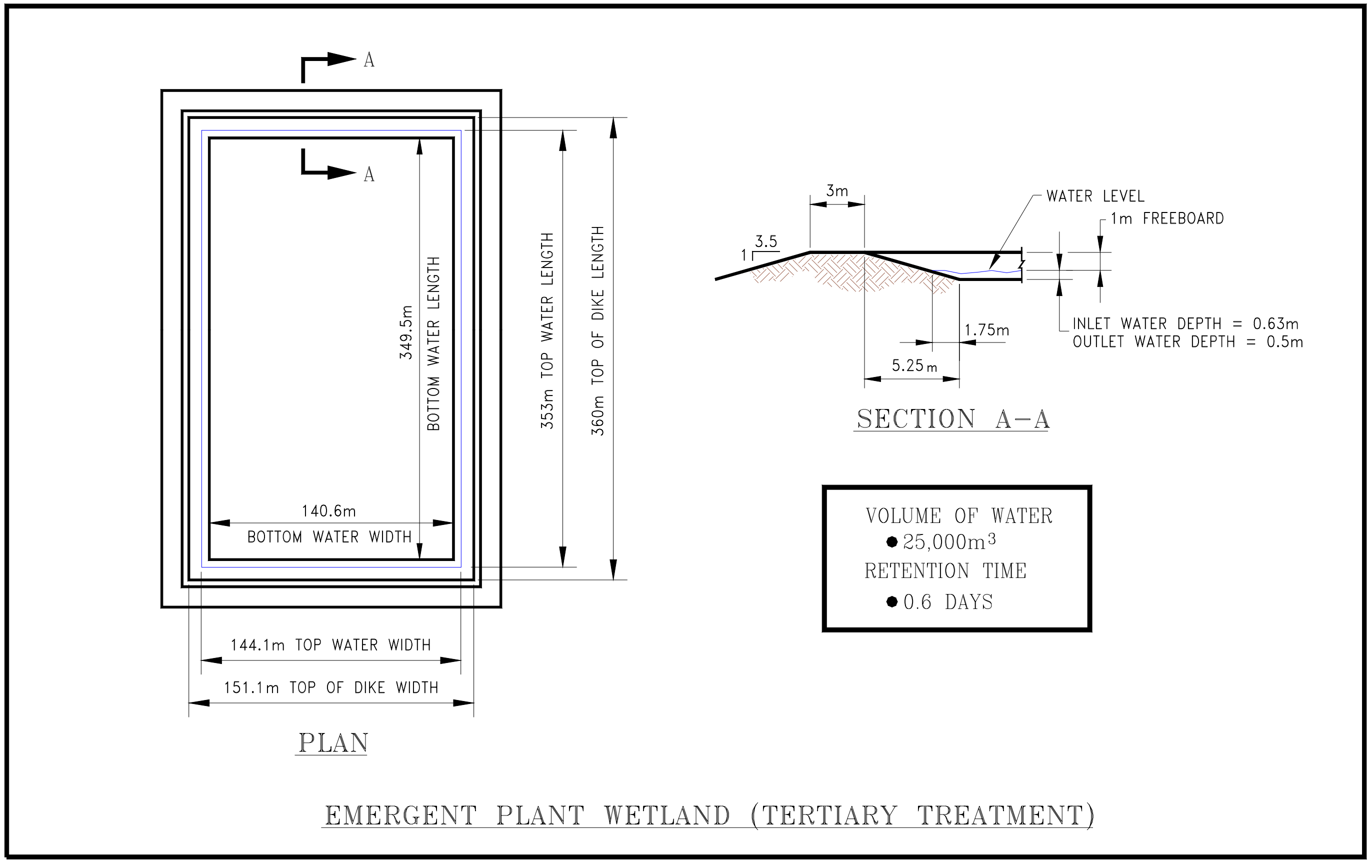

Figure IV-4. Preliminary layout of emergent plant wetland as tertiary treatment.

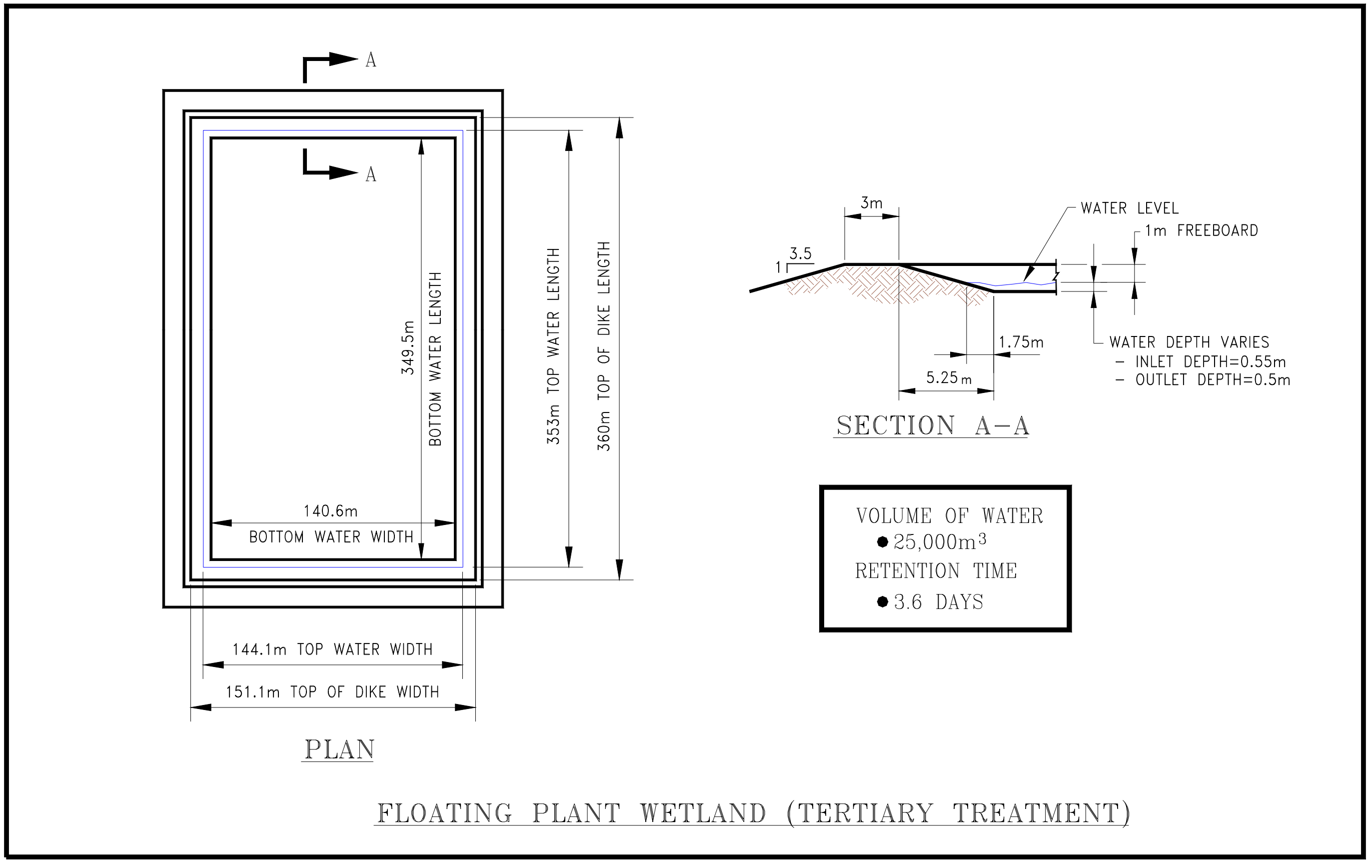

Figure IV-5. Preliminary layout of floating plant wetland as tertiary treatment.

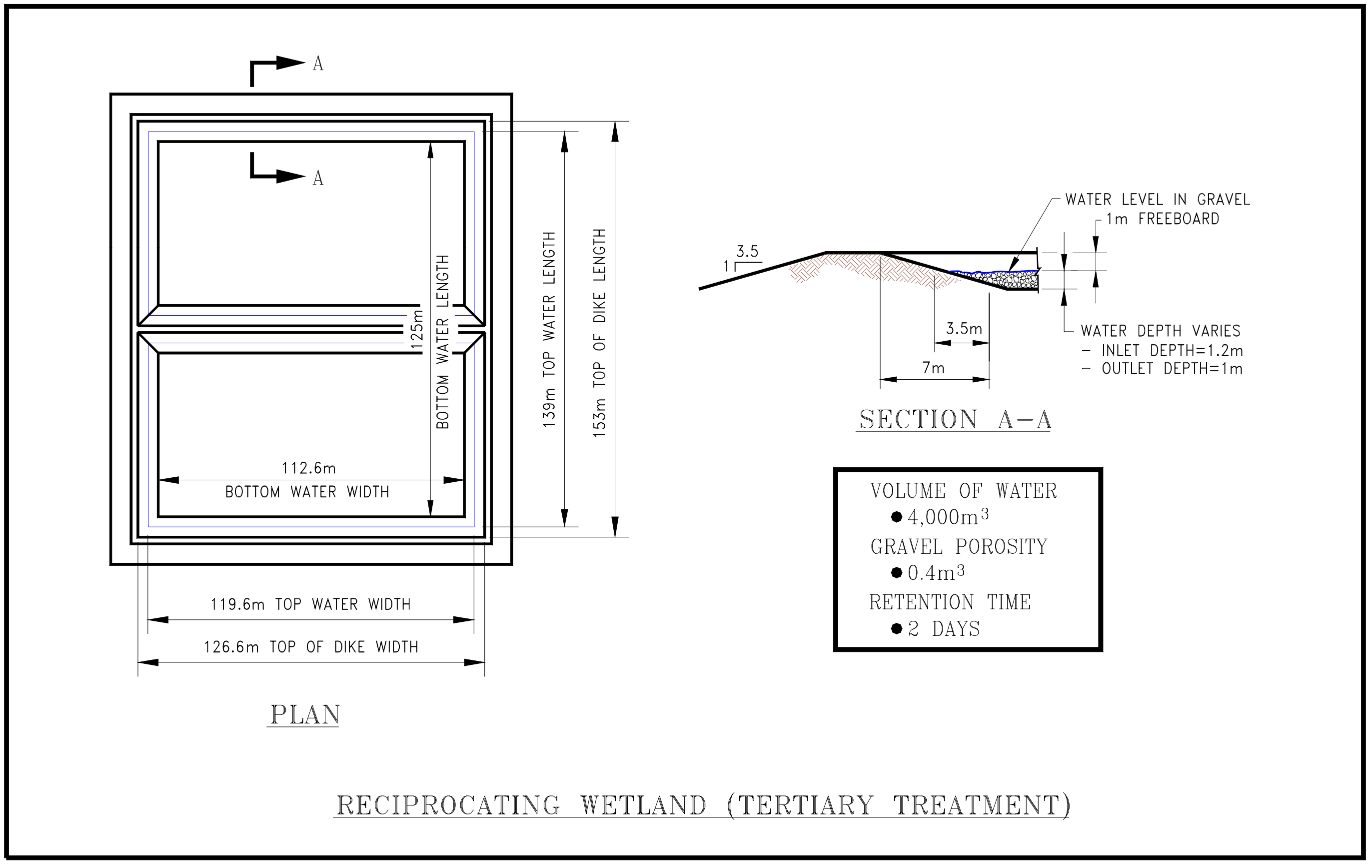

Figure IV-6. Preliminary layout of reciprocating wetland as tertiary treatment.

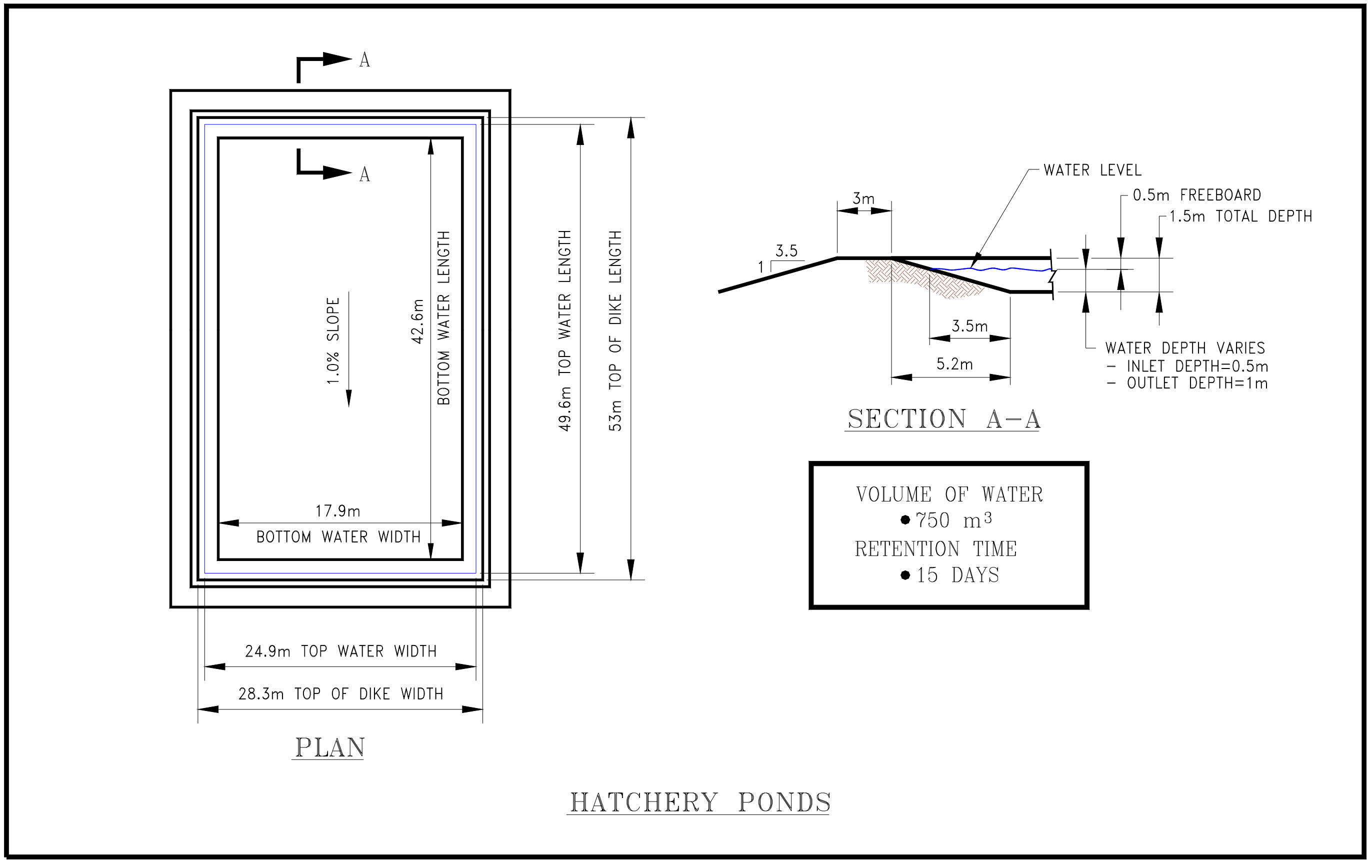

Figure IV-7. Preliminary layout of hatchery ponds

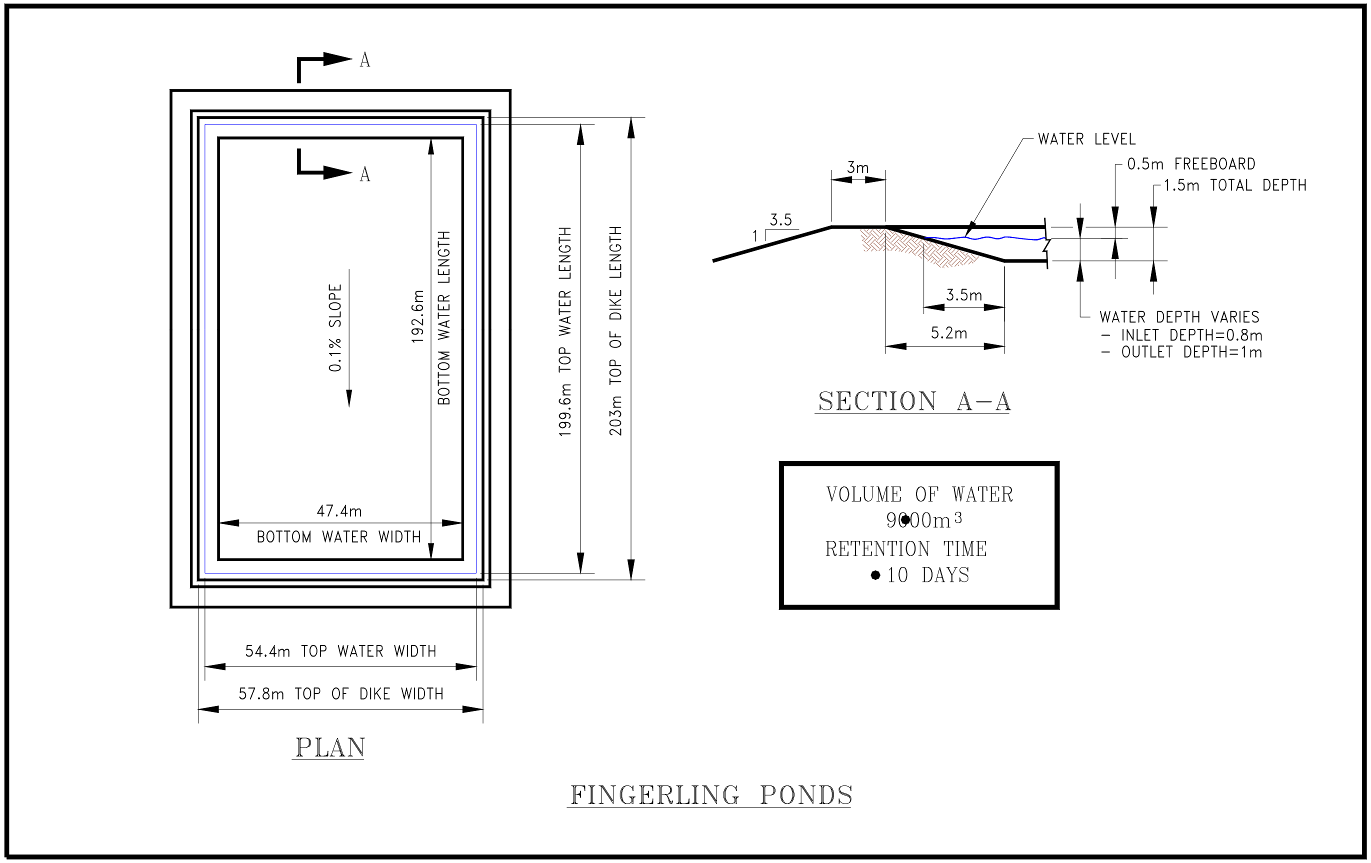

Figure IV-8. Preliminary layout of fingerling ponds.

ANNEX V. PRELIMINARY MONITORING PLAN

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ANNEX V PRELIMINARY MONITORING PLAN

1.0 Environmental Monitoring

Performance of the wetland system will be monitored during the fourth and fifth year of the project. Preliminary sampling and analyses will be conducted during the six-month period prior to year four. A detailed monitoring plan will be developed in draft form by month 18 of the project. The plan will be finalized by month 30.

A field laboratory and field monitoring equipment will be provided as part of this project. A monitoring subcontract will be used for field personnel and laboratory analyses that cannot be conducted in the field. The field personnel will collect all samples, conduct field analyses and tests, and ship laboratory samples to the contract analytical laboratory.

1.1 Preliminary Objectives and Scope

The basic objectives of the monitoring program are to:

A. Evaluate the performance of the different treatment systems and alternative methods of operation.

B. Identify operational procedures that will optimize treatment levels and economic returns.

C. Develop a database for designing similar treatment system for application in other locations.

The suggested monitoring parameters, frequencies, and analysis location are given in Table V-1. Where laboratory analytical procedures are required, the reference methodology will be *Standard Methods for the Examination of Water and Wastewater* (Greenberg et al., latest edition). All samples will be collected, handled, and preserved in accordance with recommended procedures.

As described in Annex I, the wetland system will be operated under two basic flow regimes. One treatment pathway will involve high flow rates with moderate to low pollutant removal efficiencies. The second treatment pathway will involve low flow rates with higher pollutant removal efficiencies. The two flow regimes will be started at the beginning of year four. The first year of operation will provide data over the period of wetland plant establishment. Monitoring data from the second year of operation will provide information on treatment efficiencies after the wetlands have been established. Pollutant removal efficiencies will be determined during the period of wetland plant establishment and continual treatment under the two different flow regimes.

1.2 Sampling Locations

The basic monitoring program will sample the flow and quality of waters entering the wetlands: the water, sediments and plants at various locations in the wetland, and the flow and quality of water leaving the wetlands. A general description of the monitoring locations is provided below.

A. Inflow Water Quality--Water quality and hydrometric data will be collected from the sedimentation basin inflow from the Bahr El Baqar drain and just upstream of the intake.

B. Water Chemistry Data from the Wetland System--Water samples and chemical field data will be collected from all influent and effluent stations for each individual wetland cell so that a detailed mass balance of various water quality parameters and a water budget can be developed.

C. Sediment and Biological Sample Data from the Wetland System--Sediment, algae, plants, and benthic invertebrates will be collected near the influent and effluent of each wetland cell to assess the transfer of pollutants. Fish will also be sampled in the aquaculture ponds to assess uptake of pollutants in the fish. These data will be used in evaluating the potential health implications of recycling biomass products into animal feed and sediments into bricks.

D. Precipitation and Evaporation–Precipitation and evaporation data will be collected daily to allow a complete water balance for the wetland system.

1.3 Field and Laboratory Analyses

Table V-1 indicates which parameters will be measured in the field and which are to be conducted in the laboratory. A field laboratory will be constructed and equipped to accommodate the equipment, instrument calibrations, and field parameter analyses. This laboratory will include analytical balance and filtration equipment for TSS, turbidity, pH and BOD measurements. All other parameters will require analytical laboratory support as shown in Table V-1.

For field sampling and in situ measurements, the equipment and methodology will provide a practical and reliable method of data collection. The monitoring program will be designed to include calibration of instruments on a frequent and routine basis using fresh standards, replicate samples, and distilled water blanks for procedures such as total suspended solids (TSS). The QA/QC procedures will be documented and the results presented with the data.

Field equipment requirements are shown in Table V-2. The field team will require a light durable boat (e.g., aluminum construction) which can be used in the wetland and drain. A small outboard motor of approximately 5 h.p. will allow access to all sampling areas and will be light enough to be transported manually. Meters and instruments must be of robust construction and designed for field use.

Table V-1. Suggested monitoring parameters, frequencies, and analytical location.

Parameters	Frequency	Location of Analysis	Method of Analysis
Water Temperature	Daily	Field	thermometer
pH	Daily	Field	glass electrode
Alkalinity	Daily	Field Lab	titration
Dissolved Oxygen	Daily	Field	oxygen electrode
Electrical Conductivity	Daily	Field	salt bridge
Salinity	Daily	Field	salt bridge
Current Velocity	Daily	Field	tbd*
Flow Volumes	Daily	Field	flume height
Precipitation/Evaporation	Daily	Field	rain guage/ pan evaporator
Turbidity	Weekly	Field Lab	light scattering
TSS	Weekly	Field Lab	filtration
Drain Flow volume, Depth Current Velocity	Weekly	Field	tbd
TSS in the Bahr El Baqar and Bashtir Canal	Weekly	Field	filtration
Total Kjeldahl Nitrogen	Weekly	Lab	Kjeldahl digestion/titration
Total Phosphorus	Weekly	Lab	Kjeldahl digestion/colorimetry
Ammonium - N	Weekly	Lab	colorimetry
Nitrate - N	Weekly	Lab	Cd reduction/colorimetry
Total Organic Carbon (TOC)	Weekly	Lab	combustion/CO_2 analysis
Chlorophyll	Weekly	Lab	colorimetry
Fecal Coliform	Weekly	Lab	elevated temp. inoc.
Biological Oxygen Demand (BOD_5)	Monthly	Field Lab	5 d incubation/oxygen electrode
Chemical Oxygen Demand	Monthly	Lab	digestion/colorimetry
Heavy Metals	Monthly	Lab	atomic absorption spectroscopy
Selected Priority Pollutants	Monthly	Lab	tbd
Algal Sampling	Monthly	Lab	tbd
Benthic Invertebrates	Bimonthly	Lab	tbd
Plant Tissue Analysis	Once in Three Months	Lab	tbd
Sediment Analysis for Metals	Once in Six Months	Lab	tbd
Fish Samples	Once in Six Months	Lab	tbd

*tbd - to be determined

Table V-2. Equipment and instrumentation requirements for field monitoring.

Parameter/Sample	Equipment/Instrumentation
Sediments	Ekman or Ponar grab sampler, or equivalent
Water Level Recording	staff gauges
Dissolved Oxygen, pH, Turbidity	Standard Field Monitor
Salinity, Conductivity, Temperature (SCT)	similar to YSI or Hydrolab construction and service
Current Velocity	Aanderaa SD30 Flow Meter or equivalent
Water Sampling	Kemmerer water sampler, bottle sampler, boat and motor
Dissolved and Particulate Analysis (TSS), Size Fractionation	Filtration equipment with various sizes of filters, analytical balance, dessicator cabinet

In addition to the field measurements, laboratory analysis will be contracted to one or more laboratories on a competitive tender basis. All laboratory analyses will be conducted according to *Standard Methods for the Examination of Water and Waste Water*, latest edition.

Qualified laboratories will be asked to prepare tenders which can be analyzed on the basis of adequacy of procedures, analytical time, expertise, and cost. The competitive tender will be parameter-specific and different laboratories may be used, depending on expertise, analysis, or cost. The bidding process will be conducted on an annual standing offer basis. Contracts will cover a specific range of analyses which can be called upon as needed.

For certain analyses such as the biological parameters, the analytical laboratory will be asked to supply sample containers, preservatives, and field collection personnel. Other analyses such as trace metals will only require clean sample containers and charged acid to be supplied by the analyst. These can be filled in the field by members of the monitoring team. In either case, the laboratory will be responsible for the delivery of data which meets QA/QC standards prior to payment for services.

In addition to the routine analyses, Table V-3 lists parameters and the frequency of specific analyses that will be conducted to obtain information on the fate and pathways of selected heavy metals and pesticide residues.

Table V-3. Heavy metal and chemical residues.

Parameter	Frequency	Remarks
Hg, Cd, Zn, Cu, Cr, As, Pb, Mn, Fe	Monthly	Water, sediment, and aquatic plants
Hydrocarbons and Specific Pesticides	Once in six months	Water, sediment, and aquatic plants

2.0 Preliminary Estimate of Monitoring Costs

2.1 Environmental Monitoring Program Costs

Table V-4 provides a preliminary cost estimate for the base monitoring program to be funded as part of this project. The base program consists primarily of field and laboratory equipment, labor for sample collection, and contract laboratory analyses. Additional NGO funding of approximately $150,000 will be required to support the field laboratory, data analyses, and reporting required to fully document wetland performance. In addition to supporting monitoring efforts, these funds would support university students and others interested in operations of Egyptian wetland systems.

Table V-4. Estimated cost for monitoring program.

ITEM	COST ($ U.S.)
Field Equipment	
Water quality monitors (DO, temp, pH, etc.)	$ 5,000
TSS filtration apparatus (1500) Cabinet dessicator (1000)	2,500
Niskin type sampler (400) Bottle sampler (300) Water sample containers (1300) 14 Ft Aluminum boat and trailer (3000) 5 horsepower motor (3000)	8,000
Sediment sampler (Ekman type)	700
Sample preparation equipment	300
Current meters	3,500
Mooring, floats, etc.	500
Spares and miscellaneous	7,500
Shipping and mobilization	8,000
Field Equipment Subtotal	**$ 36,000**
Additional Laboratory Equipment	
Analytical balance	$ 20,000
Laboratory DO/ pH instruments	2,000
BOD incubator	2,000
UV visible spectrophotometer	20,000
Computers, printers, fax, etc.	10,000
Miscellaneous glassware, stirrers, hotplates, reagents, etc.	10,000
Laboratory Equipment Subtotal	**$ 64,000**
Monitoring and Analyses	
Monitoring and laboratory technicians (27 months)	$ 24,000
Contract laboratory analyses	76,000
Other Cost Subtotal	**$100,000**
Total Monitoring Cost	**$200,000**

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ANNEX VI. NATIONAL AND INTERNATIONAL PARTICIPATION FRAMEWORK AND NATIONAL JOB DESCRIPTIONS

1.0 PROJECT ORGANIZATION

2.0 TERMS OF REFERENCE

2.1 Project Manager
2.2 Senior Project Engineer
2.3 Operations Foreman

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ANNEX VI NATIONAL AND INTERNATIONAL PARTICIPATION FRAMEWORK AND NATIONAL JOB DESCRIPTIONS

1.0 Project Organization

The project will be managed within the organizational structure shown in Figure 3 (page 17). The rationale for selecting EEAA as the Executing Agency is given in Section B.4.

Construction and operation of the engineered wetland will be executed by Egyptians, including project management, engineering (civil, mechanical, and electrical sub-disciplines), construction, monitoring, botany, environmental law, geotechnical, hydrogeology, land surveys, laboratory analysis, and human resource development.

International inputs for the engineered wetland are restricted and relate to four senior professionals labeled as technical advisors in Figure 3 (page 17). An International Coordinator will be responsible for coordinating international inputs, ensuring technical oversight and evaluation. The International Field Manager will assist in monitoring design, data analysis and evaluation, and the QA/QC program.

Technical, socioeconomic, and scientific disciplines for the wetland will be staffed from Egyptian professionals. Expertise on construction and operation of large engineered wetlands is not well developed in Egypt. The International Wetland Designer and International Wetland Advisor will provide this expertise over the full five years of the project. These professionals will be selected so that one can substitute for the other as needed.

The Terms of Reference for the national experts are given below. Terms of Reference for the international project personnel and additional details on the international contract are given in Annex VII.

2.0 Terms of Reference

2.1 Project Manager

<u>Background</u>

Egypt has deteriorating surface water resources. Municipal wastewater, agricultural runoff, and industrial effluent are threatening the health and welfare of millions of people. At the same time Egypt's ability to pay for the treatment infrastructure is declining. A successful wetland demonstration project will be of interest to governments around the world that are searching for affordable solutions to wastewater treatment.

The development objective of the engineered wetland project is to improve global environmental management by upgrading national to global linkages and by reducing international water pollution, climate gases, and the decline in biodiversity. This will be accomplished by the transfer of an appropriate, cost-effective wastewater treatment technology to Egypt. This will also address a serious impediment to national and regional development, namely, poor water quality.

Qualifications

The Project Manager will have the following qualifications:

A. Ph.D. in engineering, science, or business management or equivalent expertise.
B. Ten years of experience at a high level in project management and government service.
C. Proven record in interdisciplinary project management skills.
D. Good communication skills in Arabic and English.
E. Working knowledge of government organization and decision making in Egypt.
F. Capabilities in evaluating of project and team performance.
G. Excellent personnel and financial management skills.
H. Ability to provide oversight to the local cooperatives enabling them to develop sound businesses with the wetland products.

Tasks

The Project Manager will serve as a liaison for the Project Management Board, Technical Advisors, and Technical Focal Points. The Project Manager will recruit and evaluate project personnel, prepare detailed workplans, tender subcontracts, prepare work schedules and milestones, and generally direct and coordinate implementation and completion of the project The Project Manager will have overall responsibility for the project, including reporting and financial accountability to the Project Management Committee, EEAA, and the UNDP. The Project Manager will also serve as Rapporteur of the Project Management Committee, He/she will be based in Cairo with frequent visits to the project site. The Cairo base is essential because of the liaison needed with the government personnel.

The Project Manager will be required to participate in and contribute to the following tasks (numbered according to the objective outputs):

1.1 Community Participation
1.2 Capacity Building
1.3 Technology Transfer
2.1 Preconstruction Work
2.2 Wetland Construction
2.3 Socioeconomic Opportunities
2.4 Operation and Monitoring

Reporting Requirements

The Project Manager will participate in the preparation and submission of the following reports:

Tender documents
Annual reports
Project Performance Evaluation Reports (PPER)
Terminal Report

2.2 Senior Project Engineer

Background

Egypt has deteriorating surface water resources. Municipal wastewater, agricultural runoff, and industrial effluent are threatening the health and welfare of millions of people. At the same time Egypt's ability to pay for the treatment infrastructure is declining. A successful wetland demonstration project will be of interest to governments around the world that are searching for affordable solutions to wastewater treatment.

The development objective of the engineered wetland project is to improve global environmental management by upgrading national to global linkages and by reducing international water pollution, climate gases, and the decline in biodiversity. This will be accomplished by the transfer of an appropriate, cost-effective wastewater treatment technology to Egypt. This will also address a serious impediment to national and regional development, namely, poor water quality.

Qualifications

The Senior Project Engineer will be an experienced professional in project implementation with a broad background in consensus building and local participation. Minimum qualifications include:

A. A professional engineer with a B.A. or B.S. degree in civil engineering or equivalent expertise.
B. Proven record in interdisciplinary project management.
C. Ten years of experience in the design and construction of large-scale public works projects having hydraulic components.
D. Familiarity with the environmental problems of Egypt's coastal lakes and drains.
E. Excellent project and business management skills.
F. Fluent in Arabic and English.
G. Experience integrating inputs of local and national participants.
H. Working knowledge of local governmental organizations and decision making.
I. Ability to work constructively with local residents in developing project support and business opportunities.

Tasks

The Senior Project Engineer will be responsible for coordinating day-to-day construction and operation of the engineered wetland and will be located at the project site. He/she will be responsible for local administration of the project, preparation of detailed workplans, recruitment of project personnel, establishment of project offices and field station, tendering of subcontracts, liaison with interested parties, project and personnel performance evaluation, and general reporting and accountability. He/she is responsible for the inspection and verification of the construction supervisor's and subcontractor's work quality and quantity; for promoting local business development associated with the project; for gaining local cooperation and support; and for promoting wider use of the wetland technologies and aquaculture among local residents.

The Senior Project Engineer will be required to participate in and contribute to the following tasks (numbered according to the objective outputs):

1.1 Community Participation
1.2 Human Resource Development
1.3 Technology Transfer
2.1 Preconstruction Work
2.2 Wetland Construction
2.3 Socioeconomic Opportunities
2.4 Operation and Monitoring

<u>Reporting Requirements</u>

The Senior Project Engineer will be involved in preparing all project reports. The reports requiring the greatest involvement and written contributions include:

Tender documents
Annual reports
Project Performance Evaluation Reports (PPER)

2.3 Operations Foreman

Background

Egypt has deteriorating surface water resources. Municipal wastewater, agricultural runoff, and industrial effluent are threatening the health and welfare of millions of people. At the same time, Egypt's ability to pay for the treatment infrastructure is declining. A successful wetland demonstration project will be of interest to governments around the world that are searching for affordable solutions to wastewater treatment.

The development objective of the engineered wetland project is to improve global environmental management by upgrading national to global linkages and by reducing international water pollution, climate gases, and the decline in biodiversity. This will be accomplished by the transfer of an appropriate, cost-effective wastewater treatment technology to Egypt. This will also address a serious impediment to national and regional development, namely, poor water quality.

Qualifications

The Operations Foreman will have the following minimum qualifications:

A. Ten years of supervisory management experience in construction, operations and maintenance of water related projects.
B. Good communication skills in English and Arabic.
C. Knowledge of pumps, hydrology, and aquatic biota.
D. Extensive experience in equipment operations and maintenance.
E. Knowledge of sampling techniques of water, plants, and sediments.
F. Ability to supervise personnel.
G. Familiarity with the project area and awareness of its local social, political, and economic sensitivities.
H. Familiarity with potential business opportunities with by-products produced from wetland treatment system.

Tasks

The Operations Foreman will be responsible for the day-to-day operation of the wetlands and for data and sample collection. Overseeing wetland operation will involve checking water levels and flows throughout the system. Data collection will involve analyzing water for pH, dissolved oxygen (DO), and salinity on a daily basis. The Operations Foreman will also be responsible in overseeing the potential business opportunities developed from collecting plant biomass in the wetlands and fish in the aquaculture ponds. The Operations Foreman will supervise three to eight people.

The Operations Foreman will be required to participate in and contribute to the following tasks (numbered according to the objective outputs):

1.2 Technology Transfer
2.3 Socioeconomic Opportunities
2.4 Operation and Monitoring

Reporting Requirements

The Operations Foreman will be required to provide input to the following reports:

Socioeconomic monitoring plan
Educational brochures and booklets
Public participation guidelines
Annual reports
Project Performance Evaluation Reports (PPER)

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ANNEX VII. INTERNATIONAL CONTRACT AND INTERNATIONAL JOB DESCRIPTIONS

1.0 INTERNATIONAL CONTRACT

2.0 TERMS OF REFERENCE

2.1 International Coordinator
2.2 International Wetland Designer
2.3 International Wetland Advisor
2.4 International Field Manager

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ANNEX VII INTERNATIONAL CONTRACT AND INTERNATIONAL JOB DESCRIPTIONS

1.0 International Contract

A single international contract will provide technical assistance and expertise, including an International Coordinator, Wetland Designer, Wetland Advisor, and Field Manager. The international contract will provide expertise that is not available in Egypt.

The budget for the international contract is given in Table VII-1. Annual budgets are given in Table 2 of Section J. The international contract will be organized with a 15 percent mobilization payment and semiannual reimbursable payments up to 90 percent of the contract amount. The last payment (10 percent of the contract amount) will be retained until the final report and responsibilities of the international team are completed.

Terms of Reference for the international experts are given below.

Table VII-1. International contract budget estimate - Egyptian Wetland Project.

Item	Unit	Quantity	Unit Cost ($)	Estimated Total Cost ($)
Personnel				
Professionals	pers/mo	14	$17,000	$238,000
Technical and Clerical Support	pers/mo	10	6,000	60,000
Subtotal				**$298,000**
Travel				
Airfare	rend trip	20	5,000	$100,000
Per Diem	day	150	200	30,000
Local Transportation	day	150	60	9,000
Subtotal				**$139,000**
Miscellaneous				
Reproduction, Supplies, Equipment				**$ 13,000**
TOTAL				**$450,000**

2.0 Terms of Reference

2.1 International Coordinator

Background

Egypt has deteriorating surface water resources. Municipal wastewater, agricultural runoff, and industrial effluent are threatening the health and welfare of millions of people. At the same time Egypt's ability to pay for the treatment infrastructure is declining. A successful wetland demonstration project will be of interest to governments around the world that are searching for affordable solutions to wastewater treatment.

The development objective of the engineered wetland project is to improve global environmental management by upgrading national to global linkages and by reducing international water pollution, climate gases, and the decline in biodiversity. This will be accomplished by the transfer of an appropriate, cost-effective wastewater treatment technology to Egypt. This will also address a serious impediment to national and regional development, namely, poor water quality.

Qualifications

The International Coordinator should have the following qualifications: at least 15 years of experience in a related engineering or scientific discipline and:

A. A Ph.D. with at least 15 years experience in a related engineering or scientific discipline.
B. A proven record in interdisciplinary project management.
C. Substantial experience in applied scientific programs dealing with environmental impact assessment, environmental management, and rehabilitation.
D. Substantial experience in water resource management and international projects.
E. Familiarity with the environmental problems of Egypt's coastal lakes and previous experience in Egypt.
F. Excellent project management skills.
G. Good communication skills in English.
H. Experience integrating inputs of national and international experts.
I. Working knowledge of the organization and procedures of the UNDP.
J. Excellent international network of contacts needed for the project.
K. Experience in the principles and design of wastewater treatment systems and engineered wetlands.
L. Experience in project performance evaluation and monitoring.

Tasks

The International Coordinator will provide oversight to the project, assist the Project Manager with technical and administrative issues, troubleshoot potential problems, oversee monitoring results, coordinate the input of the international team, review expenditures and milestone accomplishments, and assist in the preparation of international reports, meetings, and information dissemination. The International Coordinator will provide liaison with the UNDP and the Executing Agency.

The International Coordinator will review and provide technical advice to the Project Manager and Project Management Board as requested on the following tasks:

- 1.1 Community Participation
- 1.3 Technology Transfer
- 2.1 Preconstruction Work
- 2.2 Wetland Construction
- 2.3 Socioeconomic Opportunities
- 2.4 Operation and Monitoring

Reporting Requirements

The International Coordinator will prepare and submit the following reports:

Independent Annual Review Reports

2.2 International Wetland Designer

Background

Egypt has deteriorating surface water resources. Municipal wastewater, agricultural runoff, and industrial effluent are threatening the health and welfare of millions of people. At the same time Egypt's ability to pay for the treatment infrastructure is declining. A successful wetland demonstration project will be of interest to governments around the world that are searching for affordable solutions to wastewater treatment.

The development objective of the engineered wetland project is to improve global environmental management by upgrading national to global linkages and by reducing international water pollution, climate gases, and the decline in biodiversity. This will be accomplished by the transfer of an appropriate, cost-effective wastewater treatment technology to Egypt. This will also address a serious impediment to national and regional development, namely, poor water quality.

Qualifications

The International Wetland Designer will have the following qualifications:

A. A Ph.D. with at least ten years of wetland design experience or equivalent expertise.
B. Prior recognized experience in wetland design.
C. Evaluation of wetland performance requirements for water and sediment quality.
D. Experience in international project development.
E. Good communication skills in English.
F. Ability to produce academic and general public reports.

Tasks

The International Wetland Designer will review and provide technical advice to the International Coordinator and Project Manager as requested on wetland design criteria and tender documents. The Wetland Designer will review performance of the wetland to assure water and sediment quality objectives are being achieved; provide design modification suggestions as required; and assist with the biomass harvesting and manufacturing programs. The Wetland Designer will also provide guidance in establishing the local business cooperatives for marketing wetland and aquaculture products.

The Wetland Designer will assist with the following tasks:

1.3 Technology Transfer
2.1 Preconstruction Work
2.2 Wetlands Construction
2.3 Socioeconomic Opportunities
2.4 Operation and Monitoring

Reporting Requirements

The Wetland Designer will provide input and advice for the following reports:

Construction design drawings and specifications
Tender documents
Scientific study and monitoring workplan
Annual reports
Project Performance Evaluation Reports (PPER)
Scientific papers

2.3 International Wetland Advisor

Background

Egypt has deteriorating surface water resources. Municipal wastewater, agricultural runoff, and industrial effluent are threatening the health and welfare of millions of people. At the same time, Egypt's ability to pay for the treatment infrastructure is declining. A successful wetland demonstration project will be of interest to governments around the world that are searching for affordable solutions to wastewater treatment.

The development objective of the engineered wetland project is to improve global environmental management by upgrading national to global linkages and by reducing international water pollution, climate gases, and the decline in biodiversity. This will be accomplished by the transfer of an appropriate, cost-effective wastewater treatment technology to Egypt. This will also address a serious impediment to national and regional development, namely, poor water quality.

Qualifications

The International Wetland Advisor will have the following qualifications:

A. A Ph.D. with at least ten years experience in environmental management.
B. Extensive and internationally recognized experience in wetland design.
C. Experience with the construction and operation of large scale wetlands.

Tasks

The International Wetland Advisor will be involved throughout the project period and will act as a resource person. The International Wetland Advisor will be able to substitute as required for the International Wetland Designer.

The Wetland Advisor will assist with the following tasks:

1.3 Technology Transfer
2.1 Preconstruction Work
2.2 Wetlands Construction
2.3 Socioeconomic Opportunities
2.4 Operation and Monitoring

Reporting Requirements

The Wetland Advisor will provide input and advice for the following reports:

Construction design drawings and specifications
Tender documents
Scientific study and monitoring workplan
Annual reports
Scientific papers

2.4 International Field Manager

Background

Egypt has deteriorating surface water resources. Municipal wastewater, agricultural runoff, and industrial effluent are threatening the health and welfare of millions of people. At the same time, Egypt's ability to pay for the treatment infrastructure is declining. A successful wetland demonstration project will be of interest to governments around the world that are searching for affordable solutions to wastewater treatment.

The development objective of the engineered wetland project is to improve global environmental management by upgrading national to global linkages and by reducing international water pollution, climate gases, and the decline in biodiversity. This will be accomplished by the transfer of an appropriate, cost-effective wastewater treatment technology to Egypt. This will also address a serious impediment to national and regional development, namely, poor water quality.

Qualifications

The International Field Manager should have the following qualifications:

A. A proven track record in managing and implementing multidisciplinary field programs.
B. Extensive experience in developing and evaluating contracts and proposals.
C. Experience in data collection and laboratory analysis of water and sediment quality programs.
D. Knowledge of local conditions, regulations, and support facilities.
E. Successful experience in applied science programs dealing with environmental impact assessment, environmental management, and rehabilitation.
F. Good communication skills in English.
G. Competence in the design and execution of QA/QC programs.

Tasks

The Field Manager will review and provide technical advice to the Project Manager as requested on the mobilization and coordination of the field surveys, monitoring, construction, and operation; the preparation of contracts with Egyptian laboratories for data analyses; the supervision of field and laboratory studies; and the preparation of data reports to relevant team members.

The International Field Manager will assist with the following tasks:

1.3 Technology Transfer
2.1 Preconstruction Work
2.2 Wetlands Construction
2.3 Socioeconomic Opportunities
2.4 Operation and Monitoring

Reporting Requirements

The International Field Manager will assist in preparing the following reports:

Scientific study and monitoring workplan
Annual reports
Scientific papers

ANNEX VIII. EQUIPMENT REQUIREMENTS

1.0 CONSTRUCTION

2.0 OFFICE EQUIPMENT

3.0 FIELD MONITORING AND LABORATORY EQUIPMENT

4.0 MONITORING EQUIPMENT SUPPLIED BY ANALYTICAL SUBCONTRACTORS

5.0 PLANTING AND HARVESTING EQUIPMENT

6.0 VEHICLES

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ANNEX VIII EQUIPMENT REQUIREMENTS

The following is a preliminary list of equipment for the project. A more detailed appraisal and specific list of project requirements will be developed by the subcontractor and project consultants as soon as possible after project initiation.

1.0 Construction

Pumps, electrical transformers, piping, couplers, valves, sumps, and ancillary equipment

Supplied by subcontractor:

Excavators, draglines, trucks, bulldozers, front-end loaders, compactors, concrete mixers, vessels, survey instruments, miscellaneous implements, and tools

2.0 Office Equipment

Nonexpendable:

- Office furniture
- Personal computers, printers
- Photocopier
- Telephones
- Fax machines

Expendable:

- Stationery, data sheets, and miscellaneous office supplies
- Maps and charts of area

3.0 Field Monitoring and Laboratory Equipment

- 14-foot boat and trailer
- 5 horsepower motor
- 35 mm camera
- binoculars
- insitu water quality monitors
- total suspended solids filtration apparatus
- analytical balance (5 decimal)
- cabinet dessicator
- ultraviolet—visible spectrophotometer for colorimetric analyses
- laboratory DO and pH instruments
- temperature controlled BOD incubator
- Niskin type sampler
- bottle sampler
- field sample bottles
- Ekman type sediment sampler
- trays, pails, and containers (sediment collection)
- moored current meter
- mooring, floats, etc.
- spares and miscellaneous field items
- computers, monitors, software, printers,
- miscellaneous laboratory glassware, stirrers, hotplates, reagents, etc.

4.0 Monitoring Equipment Supplied by Analytical Subcontractors

Chemical reagents
Analytical equipment

5.0 Planting and Harvesting Equipment

Sickles, mesh-buckets, nets, shovels, rakes, containers

6.0 Vehicles

Car
Pick-up truck and trailer

ANNEX IX. BUDGET DETAILS

1.0 GOVERNMENT OF EGYPT CONTRIBUTIONS

1.1 Personnel
1.2 Land

2.0 UNDP CONTRIBUTIONS

2.1 Personnel
2.2 Duty Travel
2.3 Cairo Office
2.4 Project Equipment
2.5 Project Operations
2.6 Subcontracts
2.7 Miscellaneous

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ANNEX IX BUDGET DETAILS

1.0 Government of Egypt Contribution

1.1 Personnel

EEAA Representative	2 mth/yr (Y1, Y2, Y5); 1 mth/yr (Y3, Y4); 9500 LE/mth in Y1 with escalation factor of 1.03/yr
Project Management Board (7)	4 mth/yr (Y1-Y2); 2 mth/yr (Y3-Y4); 3 mth/yr (Y5); 12,000 LE/mth in Y1 with escalation factor of 1.03/yr
Technical Focal Points (14)	4 mth/yr (Y1-Y2); 2 mth/yr (Y3-Y4; 3 mth/y (Y5): 7000 LE/mth in Y1 with escalation factor of 1.03/yr

1.2 Land

Project Site	8000 LE/feddans; 200 feddans; This is the cost of land for the wetland site. The land will be provided before project implementation as a prior obligation.

2.0 UNDP Contribution

2.1 Personnel

Project Manager	12 mth/yr (Y1-Y5) $3300/mth in Y1 with escalation factor of 1.03/yr
Senior Project Engineer	12 mth/yr (Y1-Y5) $2700/mth in Y1 with escalation factor of 1.03/yr
Secretary	12 mth/yr (Y1-Y5) $752/mth in Y1 with escalation factor of 1.03/yr
Assistant/Driver	12 mth/yr (Y1-Y5) $940/mth in Y1 with escalation factor of 1.03/yr
Legal Counsel	3 mth in Y1

	$3000/mth in Y1
Operations Foreman	6 mth/yr (Y3); 12 mth/yr (Y4-Y5); $380/mth in Y3 with escalation factor of 1.03/yr
Unskilled Labor	24 mth/yr (Y3); 48 mth/yr (Y4-Y5); $190/mth in Y3 with escalation factor of 1.03/yr

2.2 Duty Travel

National Personnel

$8000/yr (Y1-Y5); based
- on an estimate of 20 round-trips between Cairo and Port Said per year at $130 per round-trip; and
- an estimate of 20 per diems per year in Cairo at $160 per day and 20 per diems per year in Port Said at $110 per day.

2.3 Cairo Office

Office Space	$12,000/yr	(Y1-Y5)
Office Furnishings	5,000	(Y1)
Office Equipment	15,000	(Y1)
Office Car	20,000	(Y1)
Office Utilities/Supplies	8,400/yr	(Y1-Y5)

2.4 Project Equipment

Truck and Trailer	$ 30,000 (Y3)
Maintenance Equipment	15,000 (Y3)
Monitoring/Lab Equipment	100,000 (Y3) See Annex VIII for details

2.5 Project Operations

Electricity	6 mth/yr (Y3); 12 mth/yr (Y4-Y5) $1775/mth in Y1 with escalation factor of 1.03/yr based on pumping 50,000 m^3/d, 4 m of head, 70 percent efficiency, and $0.075/kWh electricity cost

Expendable Materials	6 mth/yr (Y3); 12 mth/yr (Y4-Y5); $1600/mth
Maintenance, Repair, and Replacement	1 mth (Y3); 12 mth/yr (Y4-Y5); $2480/mth

2.6 Subcontracts

International Wetland Consultant	$110,000 (Y1); $90,000/yr (Y2-Y3); and $80,000/yr (Y4-Y5) See Table VII-1 for details
Design and Construction Supervisor	$190,000 in Y1; $70,000 in Y2, and $30,000 in Y3 based on $80,000 for site surveys, 9 percent of construction for design, and 4 percent of construction cost for supervision
Construction	$1,300,000 in Y2; and $670,000 in Y3. See Annex IV for details.
Design Modifications	$30,000 in Y3
Monitoring	$10,000 in Y3; $35,000 in Y4; and $55,000 in Y5. See Annex V for details.

2.7 Miscellaneous

UNDP Administration	$24,000/yr (Y1-Y5) based on 3 percent of project total of $4,000,000.

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ANNEX X. FINANCIAL AND ACCOUNTING ARRANGEMENTS

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ANNEX X FINANCIAL AND ACCOUNTING ARRANGEMENTS

1.0 General

1. The Executing Agency named on cover page of the project document, hereinafter referred to as "the Government," is responsible to the Administrator of UNDP for the custody and proper use of funds advanced to it by UNDP.

2. The Government will maintain separate accounts (including a separate bank account) for UNDP resources. It will use the funds provided to it only for inputs financed by UNDP, in accordance with the project budget covering UNDP's contribution. (See PPM Part III, section 30305, subsection 3.0).

3. Advances of funds to and payments by UNDP on behalf of Governments are governed by the applicable UNDP Financial Regulations and Rules and directives regarding the utilization of currencies.

4. The Government will provide UNDP with financial statements of UNDP funds received and spent, prepared in accordance with the UNDP financial year (1 January to 31 December) in English. The periodicity and content of such statements are set out below. Annual financial statements will be audited by the legally-recognized auditors of the Government's own accounts. To the extent feasible, the audit principles and procedures prescribed for the United Nations will be applied by the auditors, who will provide audit reports annually together with the reports set out below.

5. For the purpose of reporting to UNDP, US dollar equivalents will be calculated at the United Nations operational rates of exchange. The resident representative of UNDP will inform the Government of such United Nations rates of exchange and of changes thereto when they occur.

2.0 Advance of Funds

6. Advances will be made by the resident representative at the request of the Government in accordance with the project document and in the required currencies subject to the conditions set out below.

7. The Government will indicate its cash requirements from UNDP funds for each period of the schedule of advances included in the project document at least two weeks before payment is due (Attachment 1 of this annex, Request for Advance of Funds). Advances will be made by UNDP at the time indicated in the schedule of advances, in the amounts and currencies requested by the Government. (See also paragraph 9, below for requests for cash advances in currencies not available to the UNDP field office).

8. If the schedule of advances included in the project document no longer reflects actual requirements for funds, a new schedule will be prepared by the Government in consultation with the resident representative, in accordance with the format indicated in Attachment 5 of this annex, Schedule of Advances. Advances should normally be sufficient to cover anticipated cash requirements for a maximum of three months.

9. Local currency advances to the Government will normally be made by the resident representative.

10. Advances to the Government in US dollars will be made by the resident representative if this currency is available to him or her. The resident representative will arrange for advances in currencies not available to him or her to be made by UNDP headquarters or other field offices, as deemed appropriate.

3.0 Direct Payments by UNDP

11. At the request of the Government, UNDP will, after verification of the supporting documentation, make payments directly to individuals or firms providing UNDP-financed services or goods. The requests will be addressed to the resident representative who will either arrange for the payments to be made by his or her office or by UNDP headquarters. The requests will indicate payee, amounts and currencies required, justification for the request and payment instructions reflecting payee's bank, its address, and the account number.

12. The resident representative will provide the Government with statements of direct payments made by UNDP within 15 days following 30 April, 31 August, and 31 December, for incorporation in the project delivery report in accordance with paragraph 13 (b), below.

4.0 Periodic Financial Statements

13. The Government will furnish the resident representative with certified financial statements within 30 days following 30 April and 31 August and within 60 days following 31 December. The statements will include the following:

    a) <u>Status of Funds Advanced by UNDP (Attachment 2 of this annex)</u>. The statement will be submitted for each period indicated above and will be prepared in the currency of the advance. Separate statements will be issued where different currencies have been advanced. Each statement will reflect cumulatively for the year the amount of funds available at the beginning of the year, funds advanced by UNDP, funds expended by the Government during the reporting period, and the resulting balance at the end of that period. The statement will also detail expenditure incurred by month in local currency and the US dollar equivalent calculated at the applicable United Nations operational rate of exchange.

b) Project Delivery Report (Attachment 3 of this annex). The report will be submitted for each period indicated above and will reflect cumulative current-year expenditure classified according to the items listed in the approved project budget. It will incorporate the expenditure incurred by the Government and, where appropriate, the expenditure statement of the cooperating agency, if any, and the statement of direct payments made by UNDP.

c) Annual Report of UNDP-Financed Nonexpendable Equipment (Attachment 4 of this annex). The Government will furnish the resident representative, for the year to 31 December, within 60 days following that date and together with other financial statements due at that date, with an annual report of nonexpendable equipment. The report will include all UNDP-financed nonexpendable equipment furnished to the project during the year. Nonexpendable equipment purchased by the cooperating agency, if any, and furnished to the project will also be included. The report will describe each item in detail, list the identification number given by the Government and the serial or registration number assigned by the maker and reflect the cost at the US dollar equivalent at the time of purchase calculated at the United Nations operational rate of exchange.

d) Expenditure Statement for Jointly Financed Project. In the case of joint financing of project activities by the Government and UNDP and, as the case may be, other sources of assistance, the certified financial statements referred to above shall be accompanied by a separate statement reflecting expenditure for the full project covering the same period as the certified financial statements. To this expenditure statement should be added an indication of the apportionment by the Government of the reported expenditure to UNDP's contribution and other available funds.

14. If the Government cannot submit the financial statements on the date on which they are due, it will inform the resident representative of the reasons and indicate the planned submission date.

5.0 Government Annual Audited Financial Statements

15. A certified and audited annual financial statement of the status of funds advanced by UNDP, as described in paragraph 13 (a), above, will be made available by the Government to the resident representative within 120 days after the end of the calendar year.

16. The financial statement will be audited and attested to by the entity specified in paragraph 4, above.

6.0 Government Final Financial Statements

17. Upon financial completion of UNDP assistance to a project, the Government will provide final financial statements to cover the period 1 January to the date of either financial completion or refund of the unspent balance of UNDP funds, if any (see paragraph 18, below). The financial statements will be audited so as to conform to the requirements set out in section E above. The format given in Attachments 2 and 3 of this annex should be used. The statements will be provided within 120 days from the date of financial completion to the Director of Finance with copies to the UNDP resident representative.

18. If there is an unspent cash balance of UNDP funds held by the Government, that balance will be refunded by the Government in the currency of the advance not later than 30 days after the date of financial completion.

7.0 Audit by UNDP

19. All accounts maintained by the Government for UNDP resources may be audited by the UNDP internal auditors and/or the United Nations Board of Auditors or by public accountants designated by the United Nations Board of Auditors.

Attachment 1

GOVERNMENT OF ____

REQUEST FOR ADVANCEMENT OF FUNDS FROM UNDP

FOR PROJECT ____ NO: /

For the period from __________________ 19 ____ to _____________________ 19 ____

Currency	Cash in beginning of period	Estimated disbursements to end of period	required	Payment Details		
				Bank Name & Address	Title	Number

Certified by:

____
Name (typed)
Title
Government agency (department)

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Attachment 2

GOVERNMENT OF ____

STATUS OF FUNDS ADVANCED BY UNDP[a]

FOR PROJECT ____________________________________ NO: __/__/__

For the period of 1 January ________ 19 ___
(In [currency])

	Amount
A. Summary of funds received and expended (currency of advance)	
Balance at 1 January 19 ___	XXX XXX
Add: Advances received from UNDP	XXX XXX
Total funds available for project purposes	XXX XXX
Deduct: Total expenditure for year-to-date	YYY YYY[b]
Balance at …………….. 19 ___	XXX XXX
Represented by:	
Cash in bank	XXX XXX
Cash on hand	XXX XXX
Balance at …………….. 19 ___	XXX XXX

[a] A separate statement is required for each currency advanced by UNDP.

[b] This amount should be the same as the total expenditure (in currency of advance) in Table B.

B. Summary of expenditure by month

	Expenditure (In currency of advance)	UN operational rate of exchange	Expenditure (in US $ equivalent)
January	XX XXX	XX.XX	XX XXX
February	XX XXX	XX.XX	XX XXX
March	XX XXX	XX.XX	XX XXX
April	XX XXX	XX.XX	XX XXX
May	XX XXX	XX.XX	XX XXX
June	XX XXX	XX.XX	XX XXX
July	XX XXX	XX.XX	XX XXX
August	XX XXX	XX.XX	XX XXX
September	XX XXX	XX.XX	XX XXX
October	XX XXX	XX.XX	XX XXX
November	XX XXX	XX.XX	XX XXX
December	XX XXX	XX.XX	XX XXX
Total	YYY YYY[a]		XXX XXX

Certified correct by:

____
Name (typed)
Chief Accountant
Government agency (department)

Approved by:

____
Name (typed)
Title
Government agency (department)

AUDIT CERTIFICATE (As issued and signed by the Auditors) REQUIRED ONLY FOR ANNUAL AUDITED AND FINAL AUDITED FINANCIAL STATEMENTS

[a] This amount should be the same as the total expenditure for year-to-date in Table A.

GOVERNMENT OF ____

PROJECT TITLE ______________________ UNDP PROJECT NO. (____/____/___)

Project delivery report for funds provided by
United Nations Development Program (UNDP)
for the period 1 January to 19
(prepared in US dollars)

Budge Line	Description	Expenditure				
		Budget of Year	Government	UNDP Direct Payments	Cooperating Agency	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
99.00	Total		[a]			

Certified by:

____
Name (typed)
Chief Accountant
Government Agency (department)

Approved by:

____
Name (typed)
Chief Accountant
Government Agency (department)

Audit Certificate
(as issued and signed by the Auditors)
REQUIRED ONLY FOR ANNUAL AUDITED
AND FINAL AUDITED FINANCIAL STATEMENTS

[a]Total of US dollars equivalent shown in each Attachment 2.

Attachment 4

GOVERNMENT OF ____

Annual Report of UNDP-financed nonexpendable equipment[a]
For Project No:

For the year ending 31 December 19___

Description			Government Identification number	Maker's serial or registration number	Cost in US dollars[b]
Total					

Certified by:

____
Name (typed)
Title
Government agency (department)

[a] Includes those items of equipment valued at $400 or more, and with serviceable life of at least five years, and those items of equipment, although valued at less than $4000, which are office furniture, filing cabinets, office machines, attractive items (such as cameras, projectors, stop watches, briefcases) or other similar items as determined by the Government.

[b] US dollars equivalent at time of purchase calculated at the United Nations operational rate of exchange.

Attachment 5

[PROJECT NUMBER AND TITLE]

SCHEDULE OF ADVANCES[a]

		US $
A.	Funds advanced to date	XXX XXX
B.	Funds to be advanced in forthcoming 12 months[b]	
	i. To Government	

Date	Amount	
	Total	XXX XXX

	ii. To cooperating agency	XX XXX
C.	Funds to be advanced in subsequent periods	XXX XXX
	TOTAL ALLOCATION PER PROJECT BUDGET (LINE 99)	X XXX XXX

---

[a]To be included in the project document immediately following the budget for UNDP's contribution (part IV). Advances should only cover anticipated cash requirements for a maximum of three months.

[b]The period to be covered should be the 12 months following the date of approval of the project revision.

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ANNEX XI. BIBLIOGRAPHY

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ANNEX XI BIBLIOGRAPHY

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