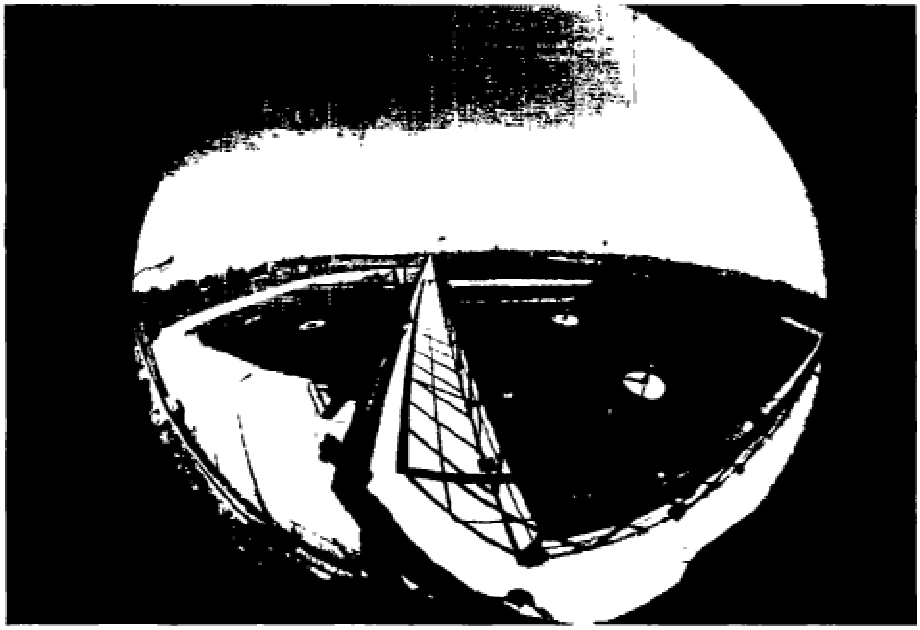
WHO ORDEV UNDP UNICEF

DRINKING WATER SUPPLY AND SANITATION SECTOR SUPPORT PROJECT IN EGYPT

(UNDP : EGY/82/002 WHO : EGY/CWS/001)

RURAL SANITATION TECHNOLOGY



WORLD HEALTH ORGANIZATION
Regional Office for the Eastern Mediterranean
Alexandria
1992

DRINKING WATER SUPPLY AND SANITATION SECTOR SUPPORT PROJECT IN EGYPT

RURAL SANITATION TECHNOLOGY

4. Rural Sanitation Technology

COTENTS

In the name of God, the Compassionate, the Merciful

FOREWORD

I am pleased to have the opportunity of contributing a foreword to this series of six booklets prepared to describe the work which has been done under the project, "Drinking Water Supply and Sanitation Sector Support", in Egypt.

It is appropriate that, at the end of the project, we should analyze what has been achieved, what have been the successes and shortcomings of the project, and what lessons we can learn for the future development of the water supply and sanitation sector not only in Egypt, but also in other countries of the Eastern Mediterranean Region.

WHO has executed this project, with the financial support of UNDP and UNICEF, to provide technical support to the Organization for Reconstruction and Development of Egyptian villages (ORDEV), in order to extend water supply and sanitation services to rural communities. WHO has been guided by the approaches of the International Water Supply and Sanitation Decade which have called for the complementarity of sanitation development with that of water supply, the inolvement of communities in the planning and execution of projects, the utilization of appropriate technologies, and the training of personnel. The project has covered both software and hardware aspects, has used improved, self-sustaining and affordable methodologies, and, with its inter-sectoral approaches, has achieved a marked success in the rural areas of Egypt where it has been possible to implement demonstration activities.

I commend these booklets as illustrative of the success of this innovative project. If they can in some small way arouse interest in the importance, to us all, of the development of a sustainable programme of water supply and sanitation in rural areas, they will have served their purpose.

Hussein A. Gezairy, M.D., F.R.C.S.
Regional Director for the Eastern Mediterranean

PREFACE

This booklet is one of a series of six in similar format prepared to demonstrate the objectives, activities and outputs of the project of the Government of the Arab Republic of Egypt, in cooperation with the United Nations Development Programme (UNDP), the United Nations Children's Fund (UNICEF), and the World Health Organization (WHO), for Drinking Water Supply and Sanitation Sector Support project.

The booklets in the series are entitled:

1. Social Aspects and Health Education
2. Sector Information Management
3. Human Resources Development
4. Rural Sanitation Technology
5. Rural Water Supply Technology
6. Leakage Detection and Control

Copies of any of these booklets can be obtained from:

World Health Organization
P.O. Box 1517
Alexandria 21511
Arab Republic of Egypt

INTRODUCTION

The activities of the project, "Drinking Water Supply and Sanitation Sector Support", started formally in January 1987, having been preceded by a preparatory phase (Phase I) from October 1984 to May 1985. The project was formulated within the context of the International Drinking Water Supply and Sanitation Decade (IDWSSD), 1981-1990, with the development objective of assisting the Ministry of Local Government to extend water supply and sanitation coverage to Egyptian villages (numbering about 30000) and to other underserved sections of the population through improved infrastructures, human resources development and transfer of appropriate technology.

It was recognized that activities in the water supply and sanitation sector had been considerably accelerated in the first half of the Decade. The purpose of this project has been to build on this initiative and to support further development through:

- introduction and demonstration of affordable, appropriate technologies based on technical, economical and social feasibility;

- establishment of a human resources department comprising of specialists and trainers for the planning and organization of training of water supply and sanitation personnel;

- upgrading of local capabilities in operation and maintenance, management, water and waste-water analysis, through appropriate training courses;

- assessment of sector information processes, identification of needs, and development of improved management information systems.

Accordingly a priority area of activity of the project was to be in the development, implementation and demonstration of appropriate sanitation technologies. There had been, prior to and in the first years of the International Drinking Water Supply and Sanitation Decade 1981-1990, considerable activity to promote the supply of water to unserved areas with increased national and lateral investment to the sector. Not much had been done, however, to accord to the sanitation sub-sector the priority it deserved. The responsible authorities had recognized this and the installation of rural sanitation facilities was becoming a major concern. The expansion of water supplies with an unbalanced development of sanitation facilities had had, however, the effect of creating new technical and organizational problems which required urgent solution.

This booklet describes the actions taken under the project to prepare guidelines for the most appropriate technologies to meet different situations, and to demonstrate models in several villages utilizing the best and most economical methods suited to the climatic conditions and customs encountered in various parts of the country. The impact of these activities and the plans to extend them in years to come are also referred to.

SPECIFIC OBJECTIVES

The specific objectives of the project which are related to Rural Sanitation Technology are summarized below.

- To review the existing situation with regard to rural sanitation in Egypt, including coverage, technologies used, scope for improvement and resources available;

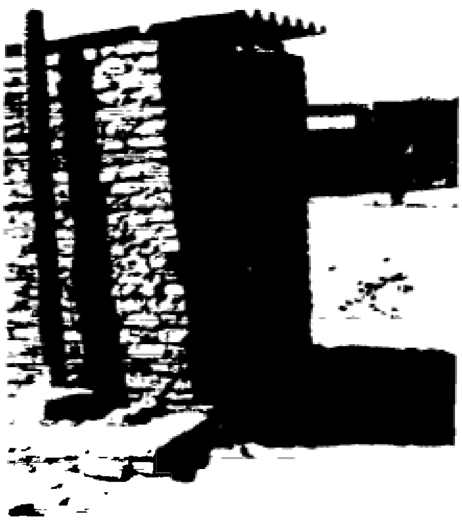
- To develop and demonstrate least-cost appropriate technologies, including the following:

  - Pit latrines:
    - in areas of low groundwater
    - combined with Small-Bore Sewer Systems (SBSS)

  - Rural sewage treatment technologies:
    - waste stabilization pond system
    - oxidation ponds system;

- To incorporate, at all stages of development and demonstration, the participation of the communities concerned and, in particular, the involvement of village women, in decision-making and health education;

- To study the reaction of the communities, the local authorities and the central organizations to the technologies introduced and to make plans for expansion and extension to serve other communities in Egypt.



MODEL VIP LATRINE IN USE
ABABDA, ASWAN

PROJECT APPROACH

During the preparatory phase of the project, October 1984 to December 1985, certain designs for demonstration projects had been initiated, and included:

- the preparation of a demonstration project for introducing the VIP latrine in selected rural areas, to be followed by a comprehensive self-help project of latrine construction; and

- the preparation of design criteria and calculations for two alternative systems of least-cost, effective technology for rural sewage treatment facilities.

In addition to the studies undertaken and reports made by staff of the project, several international consultants were engaged to provide expert advice and to review progress. These included the following:

- April 1985. Low-cost Sanitation Technologies for Rural Egypt. Porter, M.A.

- December 1985. Review, Recommendation and Design Criteria on Rural Sanitation. Porter, M.A.

- January 1986. Assessment of Sanitation Needs of Selected Egyptian Villages. Mann, H.

- July 1987. Assessment of Compact Sewage Treatment Plants for Rural Egypt. Hespanhol, I.

- August 1987. Appropriate Sanitation Technologies for Rural Egypt. Hespanhol, I.

- December 1987. Preliminary Design of Waste Stabilization Ponds Systems for Rural Egypt. Hespanhol, I.

- January 1988. Primary Design of Waste Stabilization Ponds for El Nazla, Fayoum. Gloyna, E.F.

- July 1988. Basic Design of Stabilization Pond Sewage Treatment Plants for El Nazla Village, Fayoum, and Mit Mazah Village, Daqahliya. Pescod, M.B.

- July 1988. Assessment Report for Compact Sewage Treatment Plants or Package Plants. Mullick, M.A.

- August 1988. Evaluation Report on VIP Latrine Scheme I, Minshat Kasseb Village, Giza Governorate. Mullick, M.A.

- August 1988. Modified Basic Designs of Stabilization Pond Sewage Treatment Plants for El Nazla Village, Fayoum, and Mit Mazah Village, Daqahliya. Pescod, M.B.

- September 1988. Basic Designs and Bill of Quantities for Small-Bore Sewer System and Anaerobic Treatment Plant at Minshat Kasseb Village, Giza Governorate. Mullick, M.A.

- December 1988. Review of Final Designs of Waste Stabilization Pond Sewage Treatment Plants for El Nazla Village, Fayoum, and Mit Mazah Village, Daqahliya, Pescod, M.B.

- January 1989. Design Report on Sewage Treatment Plant for Mit Mazah. Warith, A.A.

- January 1989. Design Report on Sewage Treatment Plant for El Nazla. Warith, A.A.

- July 1989. The Social Impact of Village Sanitation Experiments in Egypt. Ibrahim, Barbara.

- April 1991. Treatment Process Performance Monitoring Manual for El Nazla Sewage Treatment Plant, Fayoum Governorate, Egypt. Pescod, M.B.

- Operation and Maintenance Manual for Mit Mazah Sewage Treatment Plant.

- Operation and Maintenance Manual for El Nazla Sewage Treatment Plant.

- Monitoring the Function of and Effluent Reuse Study on Mit Mazah Sewage Treatment Plant, Daqahliya Governorate, Egypt. Pescod, M.B.

- Monitoring the Function of and Macrophyte Study on El Nazla Sewage Treatment Plant, Fayoum Governorate, Egypt. Pescod, M.B.

- 1991. Report on Mit Mazah Monitoring. Hamilton.

The work carried out under the project in each of the activities developed is described in the following sections.

1. REVIEW OF EXISTING SITUATION

At the start of the International Drinking Water Supply and Sanitation Decade 1981-1990, more than half of the population of Egypt was classified as rural and was concentrated in communities in the Nile Valley and in the Delta. The average population density in these areas was higher than 500 persons per km2. It was estimated that only 5% of this rural population were served with any type of sanitary excreta disposal facility and sanitation aspects were thus far below acceptable levels. In most small villages and hamlets, stables were used for human defecation and the resulting mixture of human and animal wastes was used as fertilizer in the fields.

Undoubtedly as a consequence of the poor sanitary conditions together with an unsatisfactory water supply in most cases, prevalence of communicable diseases was high. The principal among these were typhoid, diarrhoeas and dysenteries, infective hepatitis and schistosomiasis.

A report made in April 1985 by Porter provides details of the range of six options for excreta disposal used in rural villages. These were:

- Barrel latrines: bucket type, in which excreta was deposited in small containers which were emptied into drainage canals when full; considered inadequate and hygienically unsafe.

- Pit latrines: common in many villages as simple pits or offset with pour-flush bowls connected by short pipes; can provide hygienic disposal in low density areas, but require an emptying service and may pollute ground water.

- Direct discharge: waterseal bowls or WCs connected by short sewers discharging directly into drainage canals; constitute a serious public health danger.

- Vault systems: theoretically watertight pits emptied as required by pumping into tankers; often accompanied by soak-aways.

- Septic tanks: theoretically a watertight tank accepting all liquids and excreta, allowing settlement to occur in the tank and sludge to accumulate over long periods for periodic removal; partly treated liquid effluents disposed of in soakage trenches, secondary treatment or direct to drains; satisfactory if well maintained.

- Nil sanitation: direct disposal of excreta in fields, stables or streets; can be a foul and dangerous practice.

Difficulty was experienced in obtaining accurate figures with regard to the systems most used, and, where data were provided, the differences between different sources was such as to cast doubt on the reliability of the figures. Nevertheless, pit latrines of one sort or another were in evidence in many areas, and probably served not less than 50% of the rural population. A lesser number of septic tanks and direct discharge systems was found, but in a large number of villages many families still had no basic latrine facility.

The systems which might be considered satisfactory, provided surveillance and maintenance standards were enforced, were:

- pit latrines in areas where no abstracted ground water was polluted;

- septic tanks in similar areas;

- direct discharge to sewers if treatment was installed before final discharge.

2. LEAST-COST APPROPRIATE TECHNOLOGIES

The following four sanitation technologies were developed in specific pilot schemes to demonstrate their appropriateness and affordability to communities in different parts of rural Egypt, with different climatic, soil and environmental conditions. as follows:

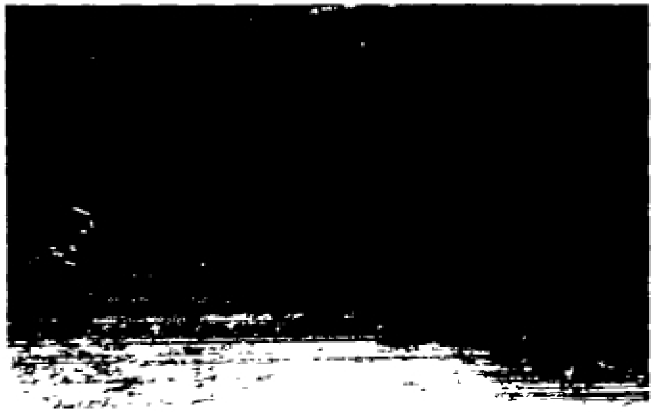
(a) Ventilated improved pit (VIP) latrines in Ababda Village, Aswan Governorate;

(b) Small-bore sewer system in Minshat Kasseb Village, Giza Governorate;

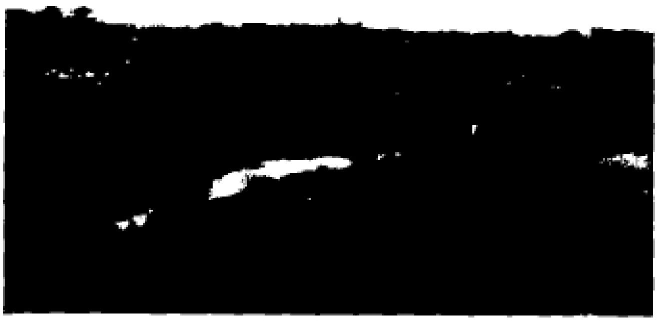
(c) Integrated sewerage and treatment pond system in El Nazla Village, Fayoum Governorate;

(d) Aerated oxidation pond system in Mit Mazah Village, Daqahliya Governorate.

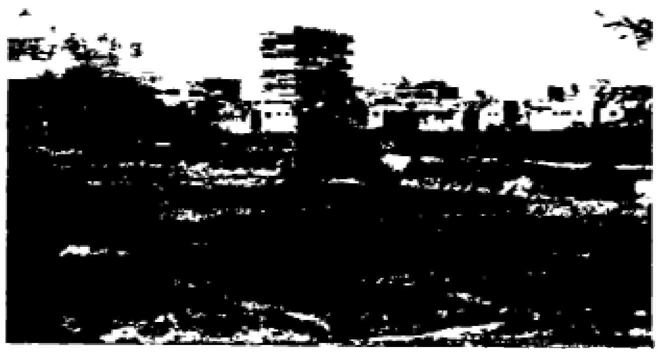
The following sections describe each of these demonstration schemes.



POOR RURAL COMMUNITY WITH
LOW WATER TABLE
ABABDA, ASWAN



TYPICAL UPPER EGYPT VILLAGE
WITH DESERTIC ZAID
EL-NAZLA, FAYOUM



TYPICAL DELTA VILLAGE WITH FERTILE LAND
MIT MAZAH, DAQAHLIYA

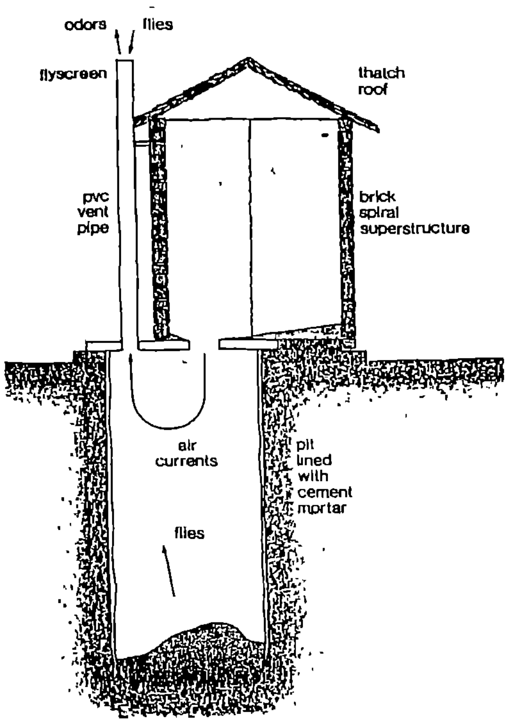
(a) Ventilated Improved Pit Latrines

In collaboration with ORDEV, the village of Ababda in Aswan Governorate was selected as typical of a village with a low water- table, where the ground water would not be polluted by the introduction of pit latrines. Ababda is a small, satellite village on the west bank of the Nile. Water has traditionally been hauled up a steep cliff from the Nile and has accordingly been used sparingly for all household drinking and washing purposes. Women have been accustomed to conserving wastewater for settling dust in their courtyards.

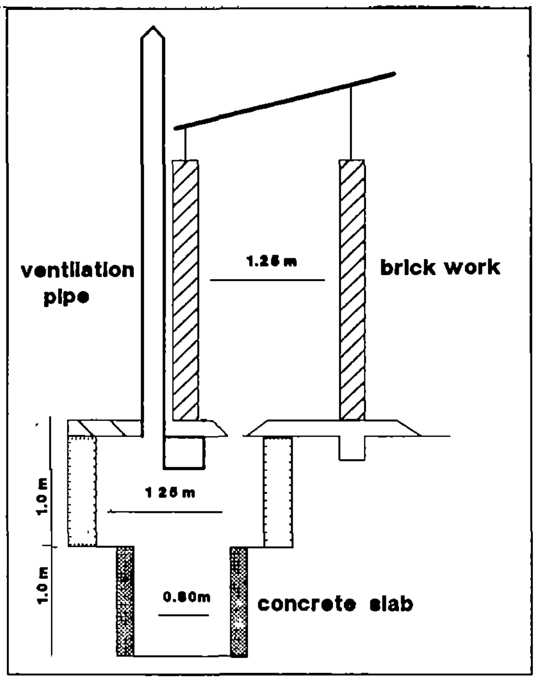
In recent years UNICEF installed four handpumps in the village with the result that the situation as to water quantity and quality has been improved despite some early problems of pumps being out of order and a lack of local ability to maintain them. A total of 27 ventilated improved pit (VIP) latrines was installed by the project, serving directly 150 persons. At the same time, a social component was introduced and a team of sociologists and health educators worked in the village to ensure community participation in the selection of households and sites for the construction of latrines. As a result, the latrines were enthusiastically welcomed, used by the houseowners and correctly maintained.

The type of VIP latrine used is shown in the drawing and photograph opposite. Technical points in the design and location included the following:

- the latrine is located outside-the home, sited so that periodic emptying can be done with the minimum of inconvenience to the householder;
- the vent pipe, which is painted black, is at least 100 mm in diameter and has a fly-proof cover to prevent flies entering or leaving the pit;
- the sides of the pit must be supported as required to avoid the danger of cave-in;
- no water-flush is required and excess water should preferably be excluded;
- for odour control, no cover should be placed over the pit when not in use as this would impede the air-flow.



SCHEMATIC DIAGRAM OF A STANDARD VENTILATED IMPROVED PIT LATRINE



SCHEMATIC DIAGRAM

(b) Small-Bore Sewer System

Minshat Kasseb village in Giza Governorate, 50 km south of Cairo, had already been selected for sociological studies by the UNDP Interregional Team of the project for Promotion of the Role of Women in Water and Environmental Sanitation Services (PROWWESS). In order to facilitate cooperation and linkage with this project, the same village was chosen to demonstrate the latrine programme for areas where the water-table was high.

The first phase of the project involved the design and construction of three communal latrines (at school, mosque and guest-house) and 20 household units, all linked to interceptors. The second and third phases would cover the provision of latrines to the remaining 121 houses of the village, and the design and construction of a small-bore sewer system (SBSS) connecting all the household interceptors and transporting the effluent to treatment.

In view of the high water-table, an early decision was taken by the project to use pour-flush water-seal system, rather than the conventional pit latrine which was prone to infiltration and periodic flooding. These, when properly constructed and maintained, were found to function well with no apparent problems. They were almost odourless, hygienic and relatively free from fly infestation. Two complaints of odour were found, on investigation, to have been caused by improper cleaning and flushing. Four of the twenty household interceptors were found to have filled up with infiltration water and they required to be relined and waterproofed. One other latrine, which had a relatively long lateral at low slope, had experienced blockage which had to be rectified.

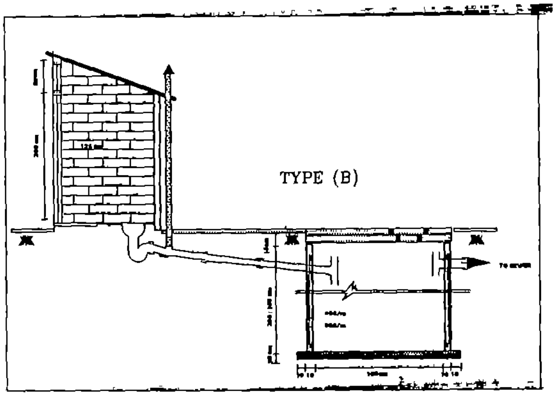
The total cost of the 20 latrines was LE 17,787 and of the three communal ones LE 4,796. The average cost of a household latrine was thus LE 889.

As a consequence of the observation of the results of Phase I, a few recommendations have been made to be taken into account in the implementation of Phases II and III:

- For design purposes, the quantity of flushing water should be increased from 2 l/c/d to 2.5 l/c/d.
- Lengthy laterals should be avoided and slopes should not be less than 2%; for old latrines, floors should be raised at least 0.30 m;
- The diameter and depth of interceptors should be as follows:
    - for 6 persons   dia 1.25 m   depth 1.50 m
    - for 10 persons   dia 1.25 m   depth 2.25 m;
- The air-vent pipe should be at least 0.50 m above the roof level.

The design of the SBSS has been based on the following:

- with the present population of 1500, the design population for a period of 20 years at 2.8% annual growth rate = 2605;
- sewage flow, based on water consumption of 45 l/c/d = 40.5 l/c/d;
- infiltration rate = 8 cu.m/km/d = 6.5 l/c/d; - total sewage flow = 47 x 2605 = 122.4 cu.m/d;
- influent pipe: dia 150 mm; max length 8 m; min slope 2%;
- interceptor tank: sludge 1-3 years storage; sullage 2-day retention; min depth 2 m; BOD removal 50%;
- effluent pipe: min dia 75 mm; min slope 1%; - SB gravity sewers: min dia 75 mm for laterals, 100 mm other; min slope to give min vel 0.25 m/sec at peak flow;
- wastewater treatment: anaerobic pond with 3 day retention.



SCHEMATIC DIAGRAM OF VENTILATED POUR-FLUSH LATRINE WITH WATERSEAL INTERCEPTOR

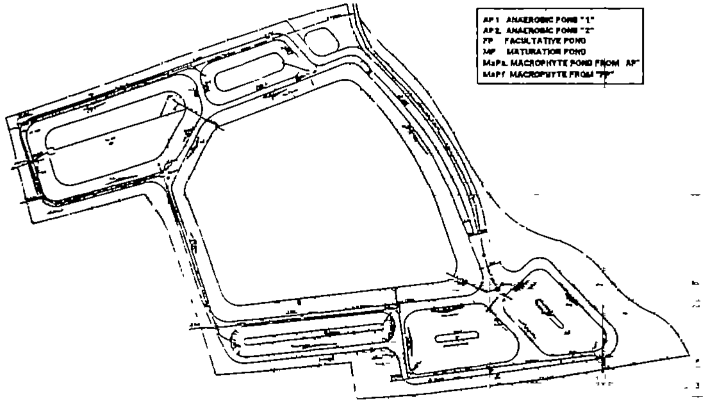
HOUSEHOLD VIP LATRINE IN MINSHAT KASSEB

(c) Integrated Sewerage and Treatment Pond System

The village of El Nazla in the Governorate of Fayoum, where the demonstration waste stabilization ponds were constructed by the project, is a traditional Egyptian village of approximately 10,000 population living mostly in adobe houses. Piped water connections are provided to many of the houses, but there has been no adequate wastewater collection and treatment facility prior to the project's intervention. The expanded sewerage network has now been completed to deliver wastewater from the village to the treatment plant which is located nearby on a plot of land of low fertility. The area is close to desertic regions and thus land for construction of ponds is more readily available than in the highly fertile and valuable agricultural land of the Delta region.

The layout of the El Nazla Sewage Treatment Plant is shown in the drawing opposite. It comprises a flow measurement device, an inlet screen, two anaerobic ponds, a facultative pond, a maturation pond and two experimental macrophyte ponds. All of these ponds are contained by soil embankments. Raw sewage enters the plant after having been pumped from the pumping station in the village. Because the capacity of the pump is much larger than the present sewage flow, the sewage is pumped intermittently to the treatment plant, with flow entering only a few hours during the day. No night-time flow will reach the plant due to the fact that the pumping station is not manned 24 hours and the pumps are operated manually. This intermittent flow does not adversely affect the treatment processes because of the relatively long retention time in each stage of the ponds.

The anaerobic ponds constitute the first major stage in the treatment process, achieving primary treatment through physical settling of solids and partial breakdown of organic material under anaerobic conditions. The inlet flow is equally divided between the two anaerobic ponds in parallel and retention time is estimated to be about 5 days in which time approximately 65% of the suspended solids and 50% of the BOD will have been removed. Sludge will have to be removed, one pond at a time,



GENERAL LAYOUT FOR EL-NAZLA SEWAGE TREATMENT PLANT

EL NAZLA PONDS UNDER CONSTRUCTION
PIPE INSTALLATION

when it reaches a depth of about 2 m after some years. This will be suitable for disposal on agricultural land, applying the necessary precautions and techniques prescribed.

Effluent from the anaerobic ponds overflows into the facultative stabilization pond. In this second stage of treatment, aerobic and facultative bacteria will break down the remaining colloidal and soluble organic material, and algae will grow to provide dissolved oxygen for bacterial growth. The effluent from the facultative pond should contain less than 10% of the original BOD. This overflows into the maturation pond where the processes of solids settlement and biological degradation continue, but, as these are at relatively low concentrations, there is a resultant clarification of the effluent.

Two macrophyte ponds have been incorporated into the design of the El Nazla sewage treatment plant as experimental and demonstration units for this type of treatment. Only a small portion of the total flow is transferred to these ponds, approximately 3% of the influent flow rate to macrophyte pond No. 1 and 10% of the influent flow rate to macrophyte pond No. 2. Both ponds are to be stocked with floating macrophytes (aquatic plants) which are known to be effective in treating effluents to a high standard, being particularly efficient in the removal of nutrients (nitrogen and phosphorus) and heavy metals. Indigenous species of floating macrophyte will be tested for their suitability in treating anaerobic pond effluent (No. 1) and facultative pond effluent (No. 2) under different loading conditions.

The treatment plant is being handed over in October 1991 and, after time has been allowed for conditions of treatment to settle down, a rigorous programme of monitoring will be established in order to assess the effectiveness of the treatment processes under a range of climatic and operational conditions. A laboratory building will therefore be provided, equipped and staffed, and additional studies will be carried out on effluent reuse.

Because this type of plant is new to rural Egypt, its cost and performance will be studied carefully in order to assess its replicability in other villages where there is no serious constraint with regard to land availability. The advantages over conventional or compact sewage treatment plants are apparent in the lack of sophisticated machinery and equipment requiring skilled operators, and its lower cost. The pump delivering the sewage from the village is the only mechanical equipment and the maintenance is confined to ensuring that blockages are attended to, screens are cleared, and the surroundings are kept in good order.

Social programmes have already been initiated with contacts with village women leaders and orientation on the works being completed. These will be accelerated as the plant becomes operational and sewer connections to houses are completed. Particular attention is being paid to the question of solid waste collection and disposal in the village, particularly with respect to its effect on the operation of the sewage treatment plant.

Two operation and maintenance manuals have been prepared and 21 operators (one engineer, one chemist, 19 technicians) received two-week theoretical and practical training. Continued on-the-job training for one year is planned.

The cost of the ponds was LE 550000 and the sewerage, including two pumping stations and the 200mm asbestos cement force pipe, LE1350000, making a total system cost of LE1900000. The cost of the ponds was met by UNDP and that of the sewerage by the Governorate and the village community.

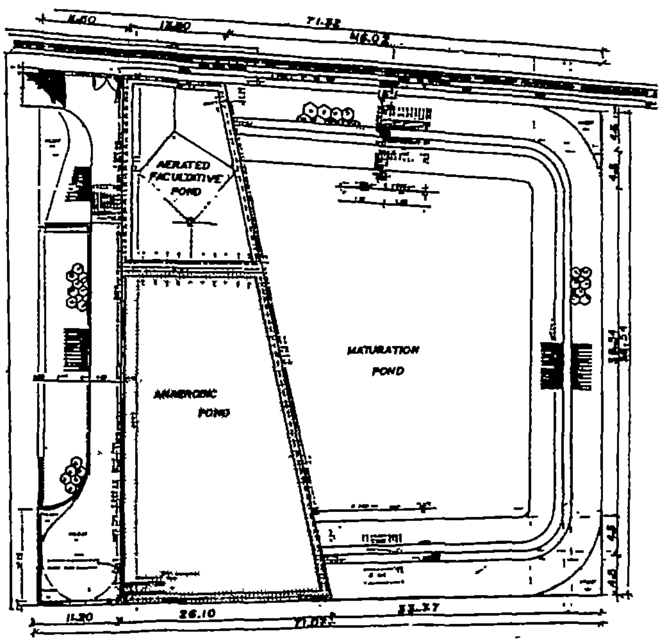
(d) Aerated Oxidation Pond System

In order to demonstrate an appropriate and low cost system of treatment of wastewater in an area where available land was scarce, the project, in consultation with ORDEV, selected the village of Mit Mazah in Daqahliya Governorate in the Nile Delta, a region of intensive agricultural production. The village is 10 km from Mansoura City and 130 km from Cairo. It has a population of about 8500 with a relatively high living standard, almost all houses having latrines, mostly connected to sewers. Prior to the construction of the sewage treatment plant, wastewater was pumped directly to a drainage canal contributing to the highly insanitary and polluted condition of this canal and providing a potential source for disease transmission.

The sewage treatment plant, which is illustrated in the drawing and the pictures opposite, consists of an anaerobic pond, an aerated pond and a maturation pond in series. The pumping station in the village pumps sewage intermittently through a magnetic flow recorder to the plant 500m outside the village on a 4200m^2 plot. Here grit and screening facilities remove large materials and the wastewater enters the anaerobic pond constructed in reinforced concrete which has a retention time of 5 days. It overflows from this pond into the adjoining reinforced concrete aerated pond where two floating surface aerators agitate the surface to oxygenate the sewage. The retention time in the aerated pond is 2 days before passage to the maturation pond for three days. This pond is contained within an embankment which is stone-lined. Its effluent discharges at present to the drainage canal, but it will probably be used in irrigation once its quality has been controlled.

The cost of the ponds was LE770,000 and the sewerage, including the pumping station and the 200mm asbestos cement force pipe, LE320000, making a total system cost of LE1090000. The ponds were paid for by UNDP and the sewerage by the village community.

It is expected that the system will have a health impact on the community through the improved sanitation from house connections and the elimination of individual cesspits. The water services to houses, ground water and surface water will also be protected from pollution. In



GENERAL LAYOUT FOR MIT MAZAH TREATMENT PLANT

MIT MAZAH AERATED OXIDATION PONDS

addition, the quality of the drainage canal in the vicinity of the outfall will be improved by the removal of organic matter, pathogens, bacteria, helminths and other potentially harmful organisms. From a social and environmental point of view, the scheme has advantages in encouraging villagers to use more water for hygienic purposes as disposal is facilitated. It should also contribute to minimizing the practice of washing clothes and household utensils in the canal as has been the case in the past.

It is believed that the scheme represents the simplest and most economical solution for disposal of wastewater from villages in the Delta. It embraces the following technical and economic benefits:

- minimum land requirement;
- construction materials, including mechanical and electrical supplies all available locally; even the floating surface aerators can be manufactured locally at much reduced cost;
- processes operating on natural treatment principles with only the secondary treatment process using simple low-cost mechanical aerators;
- minimum electrical power and no chemicals required;
- simple operation and maintenance requiring minimum spare parts and no particular skills;
- minimum surveillance staff;
- potential effluent reuse for agricultural crops and aquaculture;
- production of stabilized sludge for fertilizer.

A programme of health education and orientation of village women on the use of latrines and safe water sources is being pursued. This is referred to in more detail in Booklet No. 1.

3. CONSIDERATION OF OTHER TECHNOLOGIES

In addition to the demonstration of the two sewage treatment systems at El Nazla and Mit Mazah which were considered the best options for communities with and without readily available land respectively, a task of the project was to assess alternative technologies which might be used in rural Egypt. The following options were studied by several consultants:

- Compact or Package Plants
- Biodisc Treatment
- High Rate Filters
- Activated Sludge
- A-B System
- Extended Aeration.

Based on the recommendations of the consultants, the following summary conclusions were drawn as to the suitability of each of these technologies:

(a) <u>Compact or Package Plants</u>

If only a minimum of arable land can be freed for sewage treatment facilities, some type of compact or package plant could be used. The capital investment cost is high although this is offset by saving in land costs. Annual running costs are also relatively high due to the cost of power. Further, package plants are considered to be poor at removal of faecal coliforms and helminths. The most common process employs activated sludge with diffused air, and the use of these plants is conditioned by the same constraints, i.e. the need for continuous aeration and good sludge control. They were considered to be systems to be utilized for the solution of specific individual problems and not for general and indiscriminate use. They were excluded from the demonstration projects as it was considered unlikely that pre-designed, prefabricated plants could fit the conditions of the Delta as a whole.

(b) Biodisc Treatment

Such a system can be used for populations of 100 to 25000 or more. It is a simpler system than one using forced aeration, but major parts of the unit may have to be imported. Running costs for power are relatively expensive and semi-skilled operators are required for operation and maintenance work. It was decided not to adopt this option for demonstration.

(c) High Rate Filters

This is a modification of conventional biological filtration employing either stone media of a size larger than conventional media or specially manufactured plastic media. The objective is to provide adequate void size and capacity to accommodate high hydraulic flows and copious growth of organic biomass. The high specific surface area of the plastic media produces higher efficiency, but at a much higher cost. A compromise could be to use locally manufactured, hard fired Rashig rings using raw material available at brickworks. Such systems would only work when hydraulic flow was maintained and accordingly, under the prevailing conditions of intermittent pumping, this option was not proceeded with.

(d) Activated Sludge

Two critical operational constraints arise with all activated sludge systems. The process is virtually dependent on continuous aeration. If electricity supply or any other factor were to interrupt aeration in the high temperatures prevailing in Egypt during summer, the respiration of the activated sludge organisms would consume all available dissolved oxygen in less than one hour, would subsequently die and would enable anaerobic organisms to flourish. The process also depends on good sludge control in relation to sludge recirculation and excess sludge removal. Since these two constraints might be difficult to accommodate in a rural environment, activated sludge treatment was not recommended.

(e) A-B System

This system involves a two-stage activated sludge and biological treatment process, with an anaerobic process in stage A and bioaeration and final settling in stage B. The excess sludge from the process must be further treated before final disposal and this adds significantly to the cost. Doubts remain as to the removal efficiency of the system and additional studies are required before it can be recommended. It was decided not to use this system in the demonstration areas.

(f) Extended Aeration

Some consultants believed that some form of extended aeration process, either as a oxidation ditch or in a specially designed compact treatment plant, might have great potential for replication in the Delta area, provided the project fitted the conditions of the village, provided good flexibility and contained no automatic control system. It was felt that such a scheme could be designed by a local consulting firm with support from ORDEV and NOPWASD staff. This plant would occupy little land area, but it was decided not to proceed with this design in view of the more sophisticated operation procedures involved.

EVALUATION

Considerable progress and impact has been made by the four demonstration projects.

1. The VIP latrines at Ababda, Aswan, have been well accepted by the village community to the extent that other people from neighbouring villages who have come to learn of the project and its advantages in promoting cleanliness, hygiene and better health, have approached local government authorities to enquire whether their villages might be included in an expanded programme. They have even expressed willingness to contribute to the costs of the latrine construction materially and by providing labour.

2. The SBSS at Minshat Kasseb, Giza, which is now in its second phase, has also proved successful in that villagers who have been connected to the interceptors have recognized the advantages of being able to dispose of excreta and wastewater in a sanitary manner without polluting the surroundings of their houses. The full effects of the project will not be apparent until the SBSS is completed and the collected sewage properly disposed of.

3. The sewage treatment plant at El Nazla, Fayoum, which is not yet fully operational, is the most elaborate project component, although it is basically very simple in its operation processes. The full advantage of the removal of all wastewater from the village has yet to be appreciated, but there is no doubt that the community interest has been aroused and the scheme is welcomed. The programmes of promotion of community participation which have been initiated are meeting positive response from village women representatives and the involvement of the community in social development aspects is assured.

4. The treatment of sewage from the village of Mit Mazah, Daqahliya, is now running smoothly and satisfaction has been expressed at all levels from the Secretary-General of the Governorate through the technical staff working at the plant to the village representatives. The system is an appropriate subject for research into efficiencies of the different processes and for refinement of the technology for use in other villages of the Delta region. Interest has been shown by bilateral agencies, such as USAID, and the project is ready to offer advice and assistance to those wishing to replicate the system elsewhere.

An indication of the way in which the technology which the project has developed has attracted attention is shown in the proposal made by the Minister of Local Administration that a workshop be held in the near future to familiarize representatives of different government agencies and governorates with the technologies demonstrated at El Nazla and Mit Mazah. The WHO Regional Office has given its approval to this proposal.

LINKAGES

In carrying out the demonstration projects which are the central feature of the rural sanitation technology part of the main project, close linkages have been maintained with ORDEV as the Government Implementing Agency in all selections and decision-making. There have been very close working linkages with the authorities of the different governorates and markaz in which the pilot villages have been located, and also, obviously, with the responsible persons at village level.

Contacts have likewise been maintained with the officers of the Ministry of Health and the staff of NOPWASD, both at central and at regional and governorate levels. Particularly in the early stages, there was close communication with the team working under the UNDP PROWWESS project on social aspects and women's participation. At the same time, UNICEF has been involved in certain aspects, such as the improvement of handpump and water-tap services which have been ancillary to the project.

FUTURE ACTIVITIES

The most important single activity which requires completion is the integrated sewerage and treatment pond system at El Nazla. Indications are that the construction work will be completed in September as planned and that the commissioning will follow shortly afterwards. There must follow, as with the sewage treatment plant at Mit Mazah, a thorough monitoring period in which the various alternative loadings and processes will be carefully studied to ensure that the plants are operating successfully. Once this is established, it is considered that the suggestion of the Minister of Local Administration to hold a workshop to demonstrate these systems to senior officials from the centre and from governorates should be acted on, possibly about March 1992.

The extension of the pit latrine programmes and, in particular, the completion and implementation of the small bore sewer system in Minshat Kasseb require further attention. There is a popular demand from village communities as a result of both this project and that in Ababda for additional schemes, and this should be responded to. It is to be hoped that ORDEV and/or NOPWASD will be able to make available funds for these inputs, to which the project staff will continue to provide technical assistance.

REFERENCES

Project Reports

1. Porter, M.A. Low-Cost Sanitation Technologies for Rural Egypt. April 1985.
2. Mann, H. Assessment of Sanitation Needs of Selected Egyptian Villages. June 1986.
3. Hespanhol, I. Appropriate Sanitation Technologies for Rural Egypt. August 1987.
4. Gloyna, E.F. Primary Design of Waste Stabilization Pond for El Nazla, Fayoum. January 1988.
5. Mullick, M.A. Review Project Schemes and Small Bore Sewer Design. September 1988.
6. Pescod, M.B. Design of Stabilization Pond Sewage Treatment Plant for El Nazla Village, Fayoum, and Mit Mazah Village, Daqahliya. December 1988.
7. Warith, A.A. Design Reports on Sewage Treatment Plants for El Nazla and Mit Mazah. January 1989.
8. Ibrahim, B. The Social Impact of Village Sanitation Experiments in Egypt. July 1989.
9. Pescod, M.B. Treatment Process Performance Monitoring Manual for El Nazla Sewage Treatment Plant, Fayoum Governorate, Egypt. April 1981.

Associated Reports

10. Waste Stabilization Ponds Design and Operation. Report of a Seminar, EMRO Technical Publication No 3, 1981.
11. Wastewater Stabilization Ponds. Principles of Planning and Practice. EMRO Technical Publication No 10. WHO, Alexandria, 1987.
12. Low-Cost Water Supply and Sanitation Options. WHO/ EMRO/CEHA Inter-country Workshop Report. Amman, Jordan 1986.

Relevant Publications/Documents

13. Excreta Disposal for Rural Areas and Small Communities. Wagner, E.G., Lanoix, J.N., WHO Monograph Series No. 39, Geneva, 1956.

14. Waste Stabilization Ponds. Gloyna, E.F. WHO Monograph Series No. 60, Geneva, 1971.

15. Community Wastewater Collection and Disposal. Okun, D.A., Ponghis, G. Geneva, 1975.