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FAYOUM GOVERNORATE

MASTERPLAN DRINKING WATER SUPPLY and WASTE WATER

VOLUME III

WASTE WATER

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EL AZAB WATER WORKS and
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in cooperation with

IWACO
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DHV
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The Netherlands

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Engineering Consultants Group S.A.
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FAYOUM GOVERNORATE

MASTERPLAN

DRINKING WATER SUPPLY AND WASTEWATER

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LIST OF ABBREVIATIONS

CAPMAS	Central Agency for Public Mobilisation and Statistics
DCE	Darwish Consulting Engineers
DGIS	Directorate General for International Cooperation
DHV	Consulting Engineers, Amersfoort, The Netherlands
ECG	Engineering Consultants Group (Cairo)
FaDWS	Fayoum Drinking Water and Sanitation Project
FID	Fayoum Irrigation Department
GOE	Government of Egypt
GOF	Governorate of Fayoum
GON	Government of The Netherlands
IWACO	Consultants for Water and Environment, The Netherlands
MOH	Ministry of Health
NOPWASD	National Organisation for Potable Water and Sanitary Drainage
ORDEV	Organisation for the Reconstruction and Development of Egyptian Villages
USAID	United States Agency for International Development
WHO	World Health Organisation

l/cd	liters per capita per day
PE	population equivalent
O&M	operation and maintenance
M&E	Mechanical and Electrical (Equipment)

markaz	centre; district capital
Local unit	Municipality
ezbah	hamlet
zaribah	animal shed inside the house

H.C.	house connection
P.T.	public tap

LE	Egyptian pound
RoR	Rate of return

AC	Asbestos cement
PVC	Polyvinyl chlorine
RC	Reinforced concrete
CI	Cast iron

CHAPTER 1

INTRODUCTION

1.1 GENERAL

In the framework of the Egyptian-Netherlands development cooperation programme, the Fayoum Drinking Water and Sanitation Project is being executed. The project aims " to improve the drinking water and sanitation conditions in the Fayoum governorate to such an extent that it has a long lasting impact on the public health and the well being of the population of the governorate." One of the outputs of the first phase of the project is a masterplan for drinking water supply and wastewater.

The general objective of the masterplan is to provide an integrated strategy for the development of the Drinking Water and Wastewater Sector in the Governorate of Fayoum. Technical, institutional and socio-economic aspects are integrated in the plan.

A map of the governorate is presented in figure 1.1.

In concrete terms, the masterplan aims at formulating short and medium term programmes for:

a) Water supply and wastewater infrastructure development (investment programmes);
b) Institutional capacity building programmes (cost recovery, organisation development, human resources development).

This volume presents the Masterplan for Wastewater, covering projected future developments in the wastewater sector to provide for the needs of Fayoum's urban and rural population upto the year 2020.

Three stages in the masterplanning process were considered:

- Preliminary Masterplan (July 1992);
- Draft Final Masterplan (May 1993);
- Final Masterplan (September 1993).

The objective of the preliminary masterplan was to present at an early stage the outline, approach, basic strategy, targets, criteria and preliminary results to the involved parties, in order to obtain comments and inputs.

These inputs were then incorporated in the Draft Final Masterplan. Mainly the financial and organisational chapters of this draft plan, which were not yet included in the Preliminary Plan, were thoroughly discussed.

A general agreement on the contents of the masterplan has now been reached and is laid down in this Volume.

1.2 APPLIED METHODOLOGY

1.2.1 Phasing of masterplanning activities

Four main stages of activities can be identified in the masterplanning process (see figure 1.2):

a) Review of existing situation

An overall plan for the Governorate for future land use, physical or economic development appeared to be unavailable. For Fayoum city a drinking water and wastewater masterplan is available. NOPWASD has a programme for the construction of sewerage and sewage treatment systems in several towns and villages in the Fayoum. Valuable use could be made of the "Fayoum Environmental Profile", which provides a general picture of the Governorate (ref. 1).

In line with the regional approach for masterplanning - which is discussed in section 1.2.3 - the project adopted a combination of approaches for primary data collection.

- At regional level, population and settlement distribution, topography, soil condition and water quality aspects were studied.
- At village level, data collection included a rapid assessment of all Local Units in the governorate, and an in-depth study in five pilot villages, in order to obtain insight in socio-economic conditions and the situation with regard to wastewater disposal at household level.
- Experiences with developments in wastewater disposal and treatment in other governorates were studied.

The results of all data collection are summarised in chapter 2. Relevant details are provided in the annexes (Vol. IV) and in FaDWS technical reports, which are referred to where applicable.

b) Needs assessment and identification of sector requirements

During this stage of the masterplanning process the present conditions are compared with future needs and targets. Based on this, sector requirements can be identified. The technical wastewater options are elaborated in chapter 3, in which a distinction is made between on-site and off-site options. Needs assessment, targets and priorities for sewerage coverage are provided in chapter 4 while clusters for wastewater treatment are analysed in chapter 5.

c) Strategic planning

The first phase programme is outlined in chapter 6. Chapter 7 provides an environmental impact assessment of the wastewater plans. Cost recovery and organisational requirements are dealt with in chapter 8.

Figure 1.2. The Masterplanning Process

	PROCESS STAGE	OUTPUT	AIMED AT
A.	**REVIEW OF EXISTING SITUATION**	VARIOUS FaDWS TECHNICAL REPORTS	PROVIDING BASIC DATA
B.	**NEEDS ASSESSMENT**	PRELIMINARY MASTERPLAN	BASIC AGREEMENT ON PLANNING APPROACH AND TARGET SETTING
C.	**STRATEGIC PLANNING**	DRAFT FINAL MASTERPLAN	AGREEMENT ON INVESTMENT PLAN, ORG. DEVELOPMENT PLAN AND COST RECOVERY STRATEGY
		FINAL MASTERPLAN	APPROVAL BY GOF AND NOPWASD
D.	**PRIORITY PROJECT FORMULATION**	PRELIMINARY DESIGNS AND COST ESTIMATES	PREPARATION OF FUNDING REQUESTS

d) Priority project formulation

This stage, which will follow the approval of the Final Masterplan, results in preliminary designs and cost estimates for short term priority projects, which can be utilised for funding requests.

1.2.2 Planning horizon

The planning horizon for the masterplan is approximately thirty years (1992 - 2020). Investment and organisational development programmes cover a much shorter period: 7 to 10 years. The following approach for planning has been adopted:

- Investment requirements and organisational and financial development plans are determined in detail upto the year 2000.

- Because most of the investment works (such as sewer systems and wastewater treatment plants) have a much longer lifetime, the design horizon is also longer. For example, a new sewage pump station and force main shall normally cover the requirements for some 15 years to come in order to avoid too frequent replacements. An appropriate assesment of medium term requirements - upto 2010 - is therefore necessary.
- Any new work shall take possible future extensions into account. Of importance are especially the spatial planning and reservations of sufficient space for the future extensions. Therefore, a sketch of long term requirements - in the year 2020 - is needed.

The planning process therefore starts with an estimate of long term requirements. The medium and short term needs are subsequently assessed with an increasing degree of detail. In this way the uncertainty with regard to - especially - the longer term demographic developments can be obviated appropriately. The approach also incorporates the principle that, by the time the first short-term investment programme has been implemented, an updated second phase investment programme shall be made, adjusted to actual developments.

1.2.3 Regional approach

The methodology takes as a starting point that water supply and wastewater improvements in Fayoum have to be based as much as possible on a regional concept rather than on a single village approach. The choice for a regional approach has been made for the following reasons:

- the approach for phased planning, as explained above, can only be adopted successfully when long and medium term needs assessments are made on a governorate-wide scale. For these longer term needs, detailed information for each village (of which there are 160 in Fayoum, plus 1600 hamlets) is not required. Collection of detailed and reliable village data at this stage would consume a disproportional amount of time and resources. Only in the detailed design phase the availability of site-specific information is required;

- especially with regard to wastewater treatment and disposal the regional approach is crucial for Fayoum. The environmental impact of wastewater disposal in the drainage system asks - because of the specific hydrological conditions - for a governorate-wide assessment. The regional approach was also necessary for the development of the concept of clustering for wastewater treatment; a basic element of the masterplan.

Although Fayoum City is excluded from the Terms of Reference for the FaDWS project, it appeared to be impossible to neglect the developments in the city. In this masterplan it is foreseen that the new wastewater treatment plant of Fayoum City will get a regional function.

Also, a future merged water supply and wastewater utility is an option for Fayoum.

1.2.4 Scenarios

Masterplans often present a few alternative scenarios on how to reach a certain future situation.

In this masterplan only one scenario is presented, which is based on supporting studies analysing various possible alternatives. The following remarks can be made:

- several wastewater disposal options (on-site versus off-site, centralised versus decentralised treatment) are analysed and recommendations are made;

- the population projection in the masterplan could have been based on the official CAPMAS figures, which aim at a sharp decrease of the population growth rate from 3% at present to 0.4% after the year 2015. Since this is a disputable scenario, a more conservative decrease of population growth has been assumed;

- realistic estimates of future coverage with sewer systems is made which best mitigates the current public health hazards. The estimates are not too high in order to keep developments financially and organisationally feasible. They are not too low in order to achieve sufficient health impact. An under-estimate of coverage by sewerage would also result in an under-estimate of future water demands;

- an organisational development plan with phased targets and a cost recovery scenario are provided;

- identified projects are ranked according to priority. The pace of implementation of these projects will be determined by the finance actually available. A possible investment plan is provided.

1.2.5 Relation with the Water Supply Masterplan

The strong links and interdependency between the supply of drinking water and the disposal of wastewater are fully acknowledged in this masterplan.

There is clear evidence that water consumption in Fayoum is closely related to available wastewater facilities. If these facilities are poor, water consumption is limited; if they are in good shape, water consumption is significantly higher (see section 2.3.6). In most rural areas of the Governorate the poor on-site sanitation facilities allow only a rather modest piped water consumption of an average 50 l/cd for HC owners.

Improved wastewater facilities (sewers, improved pits and desludging facilities) may double piped water consumption in the served areas through increased per capita consumption levels and additional demand for HC's.

A close link between the water supply and wastewater plan has therefore been observed.

There is a significant gap between water supply and wastewater provisions todate, and care should be taken that the gap between the two service levels does not widen even more. In the two masterplans a balance is therefore struck between the development in the two sub-sectors; the plans are attuned to each other. It implies that, after a period of 7 to 10 years - when it is hoped that major portions of the first phase investment plans have been implemented - an evaluation of the developments in the two sub-sectors is required and an adjustment of the plans is to be made.

CHAPTER 2

EXISTING SITUATION

In this chapter, existing conditions with respect to wastewater disposal are described. First a summary of population data is provided. Secondly, a short summary is presented of the executed surveys. Thirdly, wastewater conditions are described and the present institutional framework is outlined. Finally, fields for improvement are indicated.

2.1 POPULATION

The population data of the 1986 CAPMAS census have been used as basis for population estimates. Present population figures are estimated by applying the same average population growth rates as those of the period 1976-1986 (which was estimated as 3.1 % per year). The 1992 population, calculated in this way, is given in table 2.1.

Table 2.1. Estimate of 1992 population

Markaz	Area	Population
Fayoum	Fayoum City	255,000
	Rural Areas	281,000
Tamiya	Tamiya Town	35,000
	Rural Areas	190,000
Senoures	Senoures Town	66,000
	Rural Areas	247,000
Ibshway	Ibshway Town	42,000
	Rural Areas	382,000
Etsa	Etsa Town	33,000
	Rural Areas	328,000
Total Urban Areas		431,000
Total Rural Areas		1,428,000
Total Fayoum Governorate		1,859,000

source: extrapolation of CAPMAS census of 1976 and 1986 (see annex A.1)

Fayoum City and the four Markaz (or district) capitals are classified as urban area. All other villages, which also include villages of up to 30,000 inhabitants, are classified as rural.

The settlement sizes and the number of settlements are shown in table 2.2. Detailed population data and projections upto the year 2020 are provided in annex A.1.

Table 2.2 Population distribution according to settlement size in Fayoum (1992)

Category	Number	Pop. range	Total pop.	% of pop.
Fayoum City	1		255,000	14
Markaz towns	4	33-66,000	176,000	9
Big villages	25	15-33,000	403,000	22
Small villages	132	< 15,000	668,000	36
Ezbah's	±1605	< 1,000	357,000	19
TOTAL	±1765		1,859,000	100

Source: Annex A.1.

Population statistics are available for Local Units and attached villages only. The population of ezbah's, which are included in these statistics, is estimated at 25% of the rural population.

2.2 SUMMARY OF EXECUTED SURVEYS

The project undertook various types of surveys to obtain information about present conditions with regard to wastewater disposal in the Governorate.

2.2.1 Rapid inventory in Local Units

In the inception period of the project (1990/1991) an inventory was made of water and sanitation infrastructure in Local Units, with the objective to gather information on the following aspects:

- population;
- industrial or other non-agricultural activities of some importance;
- water supply conditions;
- wastewater disposal conditions;
- groundwater conditions;
- groundwater lowering systems;
- solid waste condition;
- projects under construction, planned or recently completed.

2.2.2 Questionnaire surveys in 5 villages

More detailed information was obtained through questionnaire sample surveys in 5 selected pilot villages (see ref. 2). These surveys were not only technical in nature, but also aimed at collecting information about people's perceptions with regard to sanitation.

2.2.3 Technical in-house surveys

Detailed technical inspection of in-house facilities have been carried out in the 5 pilot villages with the objective:

- to inventorise the various types of facilities for human waste disposal currently in use, and
- to estimate the percentage of coverage of the population by these various facilities.

2.2.4 Soil permeability tests

Tests on soil permeability have been done at selected locations. Combined with information from existing soil and groundwater maps, these tests have given insight into the applicability of on-site sanitation (such as cess pits) in the Governorate.

2.2.5 Water quality surveys

A monitoring programme on water quality of agricultural drains was started. The drains are the recipients of wastewater from towns and treatment plants. The water quality data are the basis for environmental impact assessments regarding wastewater disposal.

2.3 PRESENT WASTEWATER DISPOSAL CONDITIONS

In this paragraph the findings of the various surveys are summarised. Annex B.1 provides a summary of the Local Unit survey, relevant for wastewater facilities.

2.3.1 Sewer systems

Apart from Fayoum City, only the village of El Nazla has a conventional sewerage system, complete with a treatment plant. A new treatment plant at Sanhur village has just been completed while the sewer system is presently being implemented.

Several of the larger villages have limited lengths of sewers or groundwater lowering systems which are now used as sewers. In the Local Unit survey 19 villages were found having such a system. The number of people connected to some sort of sewer is estimated at 110,000 (excluding Fayoum City).

In a number of towns and villages sewerage systems including treatment plants are planned or under construction. Table 2.3. provides an overview of existing and planned treatment plants. Figure 5.2 (chapter 5) shows the location of the planned works. It appeared that most of the treatment plants under construction or planned by NOPWASD have a design capacity which is much larger than the population of the town to be served. We will come back to this subject in chapter 6.

In the questionnaire survey, nearly 70% of the interviewed households said they are prepared to pay for the construction of a sewer connection (if there were a sewer system). Half of them are willing to pay a surcharge on the water bill for the O&M of the sewer system. Willingness to pay for sewerage seems therefore appreciable but affordability will most probably be a limitation.

Table 2.3. Existing and planned WW Treatment Plants

Location of treatment plant	Design Capacity m^3/day	Population that can be served (*)	Status	Implementing Agency
Fayoum City	40,000	250,000	being extended	NOPWASD
Tamiya	10,000	68,000	tendered	NOPWASD
Qasr Rashwan	10,000	68,000	tendered	NOPWASD
Senoures	20,000	136,000	under construction	NOPWASD
Matertaris	2,000	14,000	tendered	NOPWASD
El Edwa	1,200	17,000	tendered	ORDEV
Sanhur	2,000	28,000	existing	ORDEV
Fidimin	10,000	68,000	tendered	NOPWASD
Ibshway	20,000	136,000	under construction	NOPWASD
El Nazla	460	7,000	existing	ORDEV
El Agamien	10,000	68,000	tendered	NOPWASD
Etsa	10,000	68,000	tendered	NOPWASD

(*) NOPWASD and ORDEV apply different per-capita wastewater generation rates

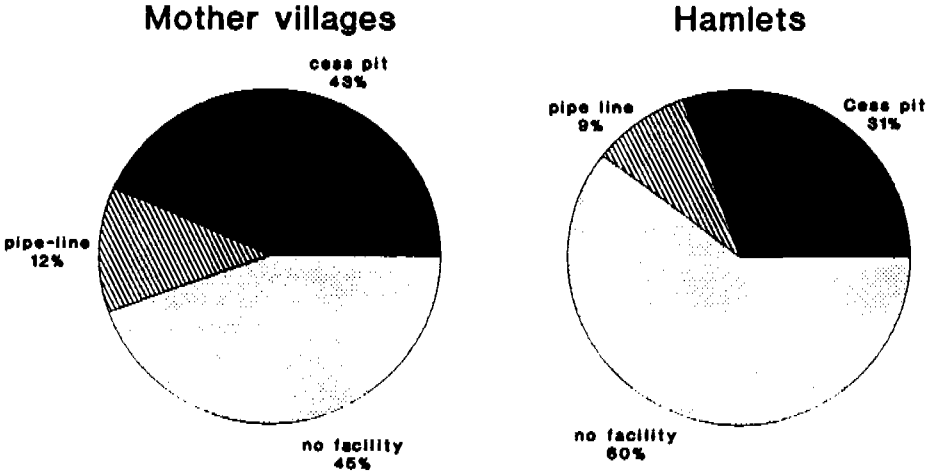
2.3.2 On-site sanitation

The majority of the population (around 90 %) have to dispose their wastewater near the house. Vaults or cess pits are common (on average 38 % of the households surveyed in the five pilot villages; see table 2.4. and figure 2.1).

Table 2.4. On-site sanitation facilities in households

Habitation	Households		Cess pit		Pipe-line		Nothing	
	No	%	No	%	No	%	No	%
Main villages	183	100%	79	43.2	22	12.0	82	44.8
Hamlets	132	100%	41	31.1	13	9.8	78	59.1
TOTAL	315	100%	120	38.1	35	11.1	160	50.8

Fig. 2.1 Waste water disposal facilities
Mother villages and hamlets



In main villages the majority of the population has access to an in-house toilet, often shared with other families belonging to the same greater family. Children may use school latrines and men use the public toilets of the mosques.

Some 50% of the population has no wastewater facility at all. Especially in poorer hamlets households having no toilet use fields and canals for defecation. Not having an in-house toilet presents a problem, especially for women, who have to go out in the night or use the zaribah (stable inside the house).

The pits and vaults [1]) often do not function satisfactory due to high groundwater tables and low infiltration capacities of the soils, and have to be emptied very often at high costs; on average LE 50 per household per year. In some villages, families may pay upto LE 80 per year for the service.

Because many cess pits are not emptied in time they overflow and cause health hazards. Problems are reported by 50% of the cess pit owners. Over one-third of the households have to deal with overflow, bad smell or a (too) small capacity of the pit for the circumstances.

Septic tanks (which retain the solids and have an overflow for the liquid part of the waste) are rare.

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[1]) Note:vaults are water tight underground chambers, intended to contain the wastewater. The vaults have to be emptied regularly.

(cess) pits are not lined, with the purpose that (part of) the wastewater infiltrates the soil. See also paragraph 3.4.1.

Only few people having cess pits use them also for the disposal of grey water (or sullage). Sullage is most often thrown in canals (45%), sometimes through pipes (10%). Many people throw the water in the street (25%).

2.3.3. Desludging services

Cess pits and vaults require periodic emptying of their contents, which is normally done with vacuum trucks. Fayoum City, the four Markaz capitals and some of the Local Units provide desludging services. The sanitation departments of the Markaz capitals each operate several vacuum trucks (see table 2.5), the few Local Units providing the services only have one truck each. In addition there are an unknown (but small) number of private enterprises that provide desludging services.

Table 2.5. Desludging Services in Markaz Capitals

Town	Number of Vacuum Trucks	Total Capacity
Tamiya	5	28 m^3
Ibshway	9	51 m^3
Etsa	7	42 m^3
Senoures	9	40 m^3

Because the infiltration capacity of the soils is so low, cess pits have to be emptied frequently; nearly all wastewater entering the pits from the toilets has to be evacuated by vacuum trucks.

The present operation practices in the Markaz towns are more or less sufficient to serve the local demands for desludging. For example in Etsa, where 45% of the population uses cess pits, the required capacity is approximately 75 m^3/day (assuming a very low per-capita sludge accumulation rate of 5 litres per day). The local sanitation department collects some 80 m^3/day. In these towns there are only short waiting lists of people requesting desludging.

Operation of the vacuum trucks is not optimal, however. In all towns only half of the equipment is in use each day; vehicles are stalled because of maintenance problems or shortage of fuel.

Desludging services in villages - where some 45% of the population, or 470,000 people have cess pits - is more problematic. Where the Local Unit doesn't have its own vacuum truck (which is the case in most villages), desludging has to be done either by the department in the Markaz capital (in 75% of the cases), or by a private enterprise (15 %). The rest of the households does the emptying by themselves.

Waiting times are long in the villages (upto 2 months are reported), also for public facilities such as schools. The result are overflowing pits. If we estimate that a similar

desludging capacity is available for the villages as for the Markaz towns, then only 20% of the demand can be covered.

The desludging services of the markaz are further restrained by cumbersome administrative procedures.

The vacuum trucks presently operated by the sanitation departments are in general too large to enter the narrow streets in the villages.

Of the approximately 350,000 people living in ezbah's, some 30% has cess pits. Desludging services in these areas are nearly non-existing.

Table 2.6 provides an estimate of the present desludging services in the Governorate (excluding Fayoum City). To serve the entire area adequately, a fleet of between 100 and 200 vacuum trucks would be needed to collect the present waste production of approximately 3,300 m^3 per day.

Table 2.6. Summary of Desludging Services 1992

	Required Capacity		Present Capacity (m^3/day)	
Area	People	(m^3/day)	Public	Private
Markaz Capitals	90,000	450	450	not known
Villages	470,000	2350	375 *)	75 *)
Ezbahs	100,000	500	very small	

* estimates

2.3.4 Disposal of sludge collected from cess pits

There are no formal disposal sites for sludge collected from cess pits and vaults (except the treatment plants of Fayoum City, El Nazla and Sanhur). The current practice is to empty the vacuum trucks in the nearest drain outside the towns.

Because of the intensive reuse of drain water for irrigation, many people - who use canal water for bathing and dish washing - come into contact with the polluted water.

2.3.5 High groundwater tables

The poor functioning of cess pits, and the resulting need for frequent desludging, is mainly caused by high groundwater tables and impermeable soils.

High groundwater tables do not only cause problems with wastewater disposal, it also affects foundations of houses. In many villages, (mud) floors and walls are permanently wet. 50% of the households interviewed mentions this problem.

There is a general belief that high groundwater levels are caused by the disposal of domestic wastewater. This is a wrong interpretation. Although wastewater will contribute to a local rise in groundwater level, the main cause is the intensive irrigation around the villages.

Many people think piped wastewater disposal will lower ground water tables in the villages. This is not to be expected unless the piped system is at the same time designed as an underground drainage system. Sewerage will not solve the problem of wet foundations, floors and walls of houses.

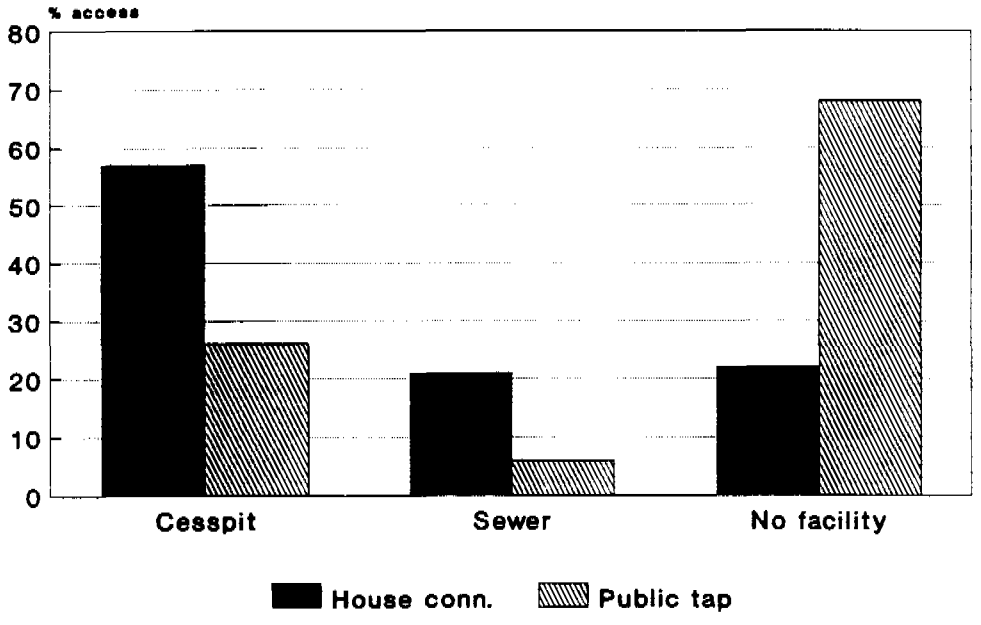
2.3.6 Relation with water supply

The problems which people face with wastewater disposal force them to minimise the use of water in the house. This effect is confirmed through measurement of water consumption by households in villages with different wastewater disposal facilities. Water consumption in a village having a sewer system is 3 to 4 times higher (Tersa, 115 l/c.d) than in a village without sewers and experiencing high groundwater tables (Kalamshah, 30 l/c.d).

It is therefore anticipated that water consumption will increase considerably once improved wastewater disposal is available in the villages.

There is a correlation between the availability of house connections for water supply and access to sanitary facilities. While 78% of house connection owners has access to a toilet, only 23% of the public tap owners has access to such a facility.

Fig. 2.2 Relation between water and sanitation facilities at household level



Moreover, of the families with house connections 21% has access to a "sewer"-line and 57% has a cess pit. For public tap users, these figures are 6% and 26% respectively (see figure 2.2.). These figures show that the availability of sanitary facilities is significantly better when a water supply house connection is available.

It might be concluded that, when people have a house connection they also tend to improve their wastewater facilities. Improvements in both fields often come together. Financial ability will play an important role.

2.3.7 Other sanitary health aspects at household level

The poor (and lack of) facilities for human waste disposal are not the only contributors to poor public health. Other factors, especially encountered in low income areas and in hamlets, are:

- the limited access to safe (piped) water,
- the extensive use of unprotected surface water (irrigation channels and drains) as second water source by over 50% of the population,
- the pollution of these waters by agriculture (pesticides), garbage and domestic wastewater,
- the improper storing and handling of drinking water inside the house,
- the custom of keeping cattle inside the houses (48% of the families have a stable inside the house); their droppings are a major breeding place for flies and other disease vectors,
- moist houses with poor ventilation,
- the general uncleanliness in and around houses (43% of the cases examined) in the form of garbage, animal faeces and ponding water,
- a general backlog in health services compared to Egypt as a whole, especially in the rural areas (ref. 1). The rural population is largely served by Rural Health Units, which serve an average population of 17,000 (1988). This is almost double the national recommended ratio of 1 RHU to 9000 population.

2.3.8 Surface water pollution

Many agricultural drains, especially where they go through villages, are polluted by domestic wastewater. High levels of organic and bacteriological pollution are measured at these locations. Garbage dumped in the drains contribute to the pollution.

Thanks to dilution, the pollution levels gradually decrease going downstream. Self purification in the drains is small which means that most of the contaminants eventually reach Lake Qarun in non-degraded form. A detailed description of pollution in the agricultural drains is provided in the FaDWS Environmental Impact Study (ref. 3).

2.4 PRESENT INSTITUTIONAL FRAMEWORK

Present responsibilities with respect to wastewater disposal are as outlined in table 2.7.

There is a concentration of responsibilities in NOPWASD with respect to project preparation, execution and financing. Responsibilities at Governorate level are limited to mainly monitoring.

Table 2.7. Present division of responsibilities for wastewater

ADMINISTRATIVE LEVEL	SEWER SYSTEMS	WASTEWATER TREATMENT PLANTS	ON-SITE SANITATION
NATIONAL LEVEL: NOPWASD	1. Planning/preparation 2. Detail.design and tendering, 3. Financing (50%) 4. Construction supervision, 5. Training for O&M	1. Planning/preparation 2. Detail.design and tendering 3. Financing (full) 4. Construction supervision 5. Training for O&M	
GOVERNORATE: Housing Department Fayoum Sanitation Department (FSD)	1. Planning/preparation 2. Monitoring of ongoing projects 3. Co-financing Monitoring of ongoing projects	 Monitoring of ongoing projects	
MARKAZ TOWN/LOCAL UNIT RURAL HEALTH UNIT	Contribution to investment Daily O&M	Daily O&M	Desludging services Advice to households
HOUSEHOLDS	Pay connection fee and service fee		Planning, financing,implementation & O&M

The Sanitation department of Fayoum has recently been established and is mostly engaged with the monitoring of the ongoing projects for NOPWASD treatment plants. Figure 2.3 shows the organisation chart of the FSD. This organisation is not yet fully implemented. FSD offices at markaz level are planned in the future. The investment costs of treatment plants are fully borne by NOPWASD, no local contribution is required. For the sewer systems however, the present policy is that the local Government and the benefitting communities should contribute up to 50% of the investment costs. Actual practice (Senoures) shows that this is hard to realise.

Responsibilities for O&M are entirely delegated to the Municipalities. Apart from Fayoum City this responsibility structure has been adopted until now only for one village (El Nazla) for the ORDEV/WHO pilot project. A similar structure has been adopted in the Governorate of Damietta, where over ten villages now have sewerage and a treatment

FAYOUM SANITATION DEPARTMENT
PRESENT ORGANISATION

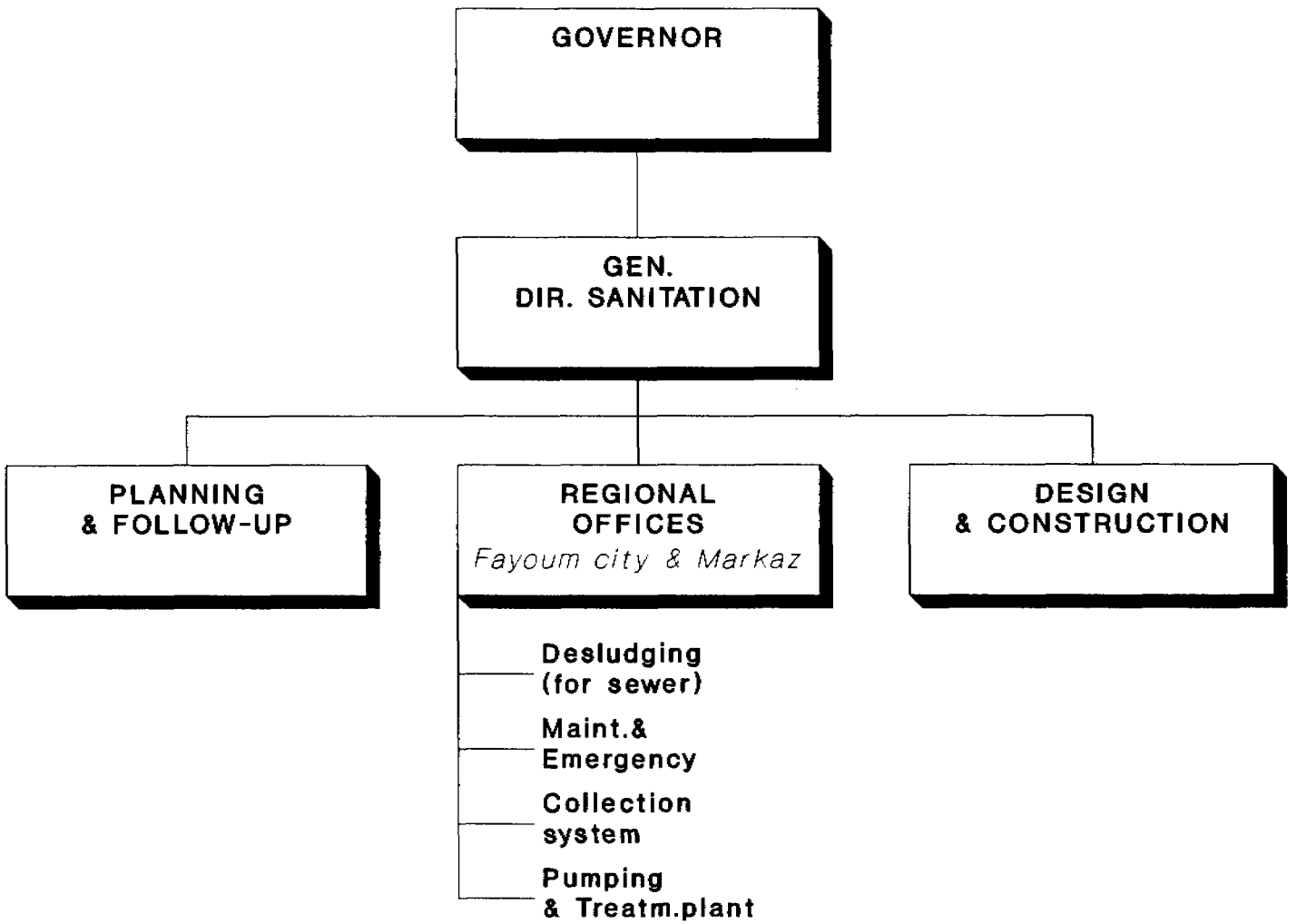


Figure 2.3

plant. The experience there shows that the individual villages cope well with O&M of the sewer systems, but for the treatment plants intensive Governorate support is required.

With regard to sanitation at household level, the Rural Health Units of the Department of Health play an important role. The units provide advice on environmental sanitation in addition to information on maternal and child health care, family planning and communicable disease control.

Responsibilities for the construction of on-site sanitation lies entirely with the household.

Desludging services are mainly provided from the Markaz towns, while only a few villages have such equipment. Capacity of desludging services is largely insufficient, while the operation efficiency can probably be increased if organisation and finance were improved. Current desludging fees only cover around 30% of the actual costs.

2.5 CONCLUSION AND FIELDS FOR IMPROVEMENT

In conclusion, the above assessment can be summarised as follows:

a) Access to facilities:
   - there is a very low coverage with sewerage in the governorate (apart from Fayoum City);
   - nearly half of the rural population has no access to a wastewater disposal facility at all;
   - The remainder (around 40%) use on-site facilities such as cess pits or vaults.

b) The proper functioning of most of these on-site facilities is complicated by:
   - high groundwater tables and impermeable soils, and
   - inadequate desludging services.

c) The poor sanitary facilities are hazardous to public health because of overflow of wastewater and the consequent restriction to the use of sufficient quantities of water by the households.

d) Present desludging services are inadequate because of:
   - lack of equipment;
   - poor operation management;
   - high cost of operation of the vacuum trucks.

e) The disposal of untreated wastewater (especially by vacuum trucks) into drains is a major source of environmental pollution.

f) There is a willingness among the population to pay for improved wastewater facilities.

g) There is a relation between the ownership of a water connection and a sanitary facility; the availability of a piped water supply connection seems to stimulate improved sanitation.

h) The institutional framework for sewerage and wastewater treatment at Governorate level is still in an early stage of development. This is logic because of the limited infrastructure available to date. During the coming ten years the sector is expected to grow considerably. Therefore organisation and management requirements at Governorate level will increase considerably. The same applies to cost recovery.

Based on the assessment of the present situation, the following fields for improvement can be identified.

1. Increase the access of the population to sanitary facilities to allow for a safe disposal of wastewater outside the houses.

2. Improve the disposal of wastewater outside the towns and villages.
   These improvements shall be achieved in two ways:
   a) by the implementation of sewerage projects, and
   b) by the improvement of desludging services in non-sewered areas.
3. Treatment of the collected wastewater before final disposal in drains, to avoid excessive surface water deterioration.
4. Developing the present organisation at Governorate level for managing sewerage and wastewater treatment.

These are general fields of improvement. A more detailed needs assessment, based on technically possible options and physical and financial constraints, is made in the following chapters.

CHAPTER 3

TECHNICAL OPTIONS FOR WASTEWATER DISPOSAL IN FAYOUM

3.1 INTRODUCTION

The main objective of any sanitary facility is to make sure that people have an ever decreasing chance of getting into contact with faecal matter. Removing faecal matter from the community and disposing this at a distance from the village (or keeping it below groundlevel in a pit) therefore is the main task of a technology. Treatment and final disposal of effluent come in the second place and depend on the environmental impact and the funds available.

The technical feasibility of various sanitation technology options is closely related to population sizes and densities and depend fully on the water service level in a particular village; full-flush toilets are not possible without a house connection to the piped water supply system. Piped sewer systems do not function properly without the amount of wastewater that comes with piped water supply.

Before a needs assessment is made, a description is given of possible technologies. In the next three paragraphs, the following technical options for wastewater disposal are presented, with indications of their possibilities and limitations:

I. Sewerage and sewage treatment,
II. The modular sewer system as an intermediate technology,
III. On-site sanitation.

In the last paragraph a cost summary is provided.

3.2 SEWERAGE AND SEWAGE TREATMENT

3.2.1 Application of sewerage and sewage treatment

In towns and larger villages, sewerage is the obvious technical solution for the following reasons:

a) population numbers

A large concentration of people results in more wastewater to be disposed of.

b) density of habitation

The character of the towns and larger villages (houses built close together without yards around the houses) makes on-site disposal practically impossible (lack of space). More so when multi-storey buildings are constructed.

c) water supply service level

Piped water supply is available in all villages in Fayoum, with the highest percentage of house connections occurring in the bigger settlements. The domestic water demand in urban areas is also higher than in rural villages, which results in a requirement for adequate wastewater disposal facilities.

d) groundwater level and soil permeability

The generally high groundwater tables and often low soil permeabilities constitute a restriction to the on-site disposal of wastewater.

Because of the large volumes of wastewater, originating from sewered towns and larger villages, it will generally be required to treat the sewage before disposal to prevent unacceptable high pollution of the receiving surface water.

3.2.2 Components of sewerage systems

In a sewerage and sewage treatment scheme, five components can be distinguished as illustrated in figure 3.1:

a) the house connections,
b) the secondary sewer system (or laterals),
c) the main collector system,
d) the conveyance system, leading from the sewer system to the treatment works,
e) the sewage treatment plant.

House connections

The house connection leads from the property line of the house to the sewer in the street. Both black water (from toilets) and sullage (other domestic wastewater) shall be collected by the sewer system, because of the absence of open drains. Collecting both types of wastewater also helps to prevent the settlement of solids inside the sewer pipes.

Although many households have vaults which could serve as interceptor tanks, it is advised to by-pass these. Storage of wastewater near (or often below) the house is not recommended. Moreover, interceptor tanks require regular and expensive desludging.

Secondary sewer system

The secondary sewer system (the laterals) collects the wastewater from the house connections and transports it to the main collector system.

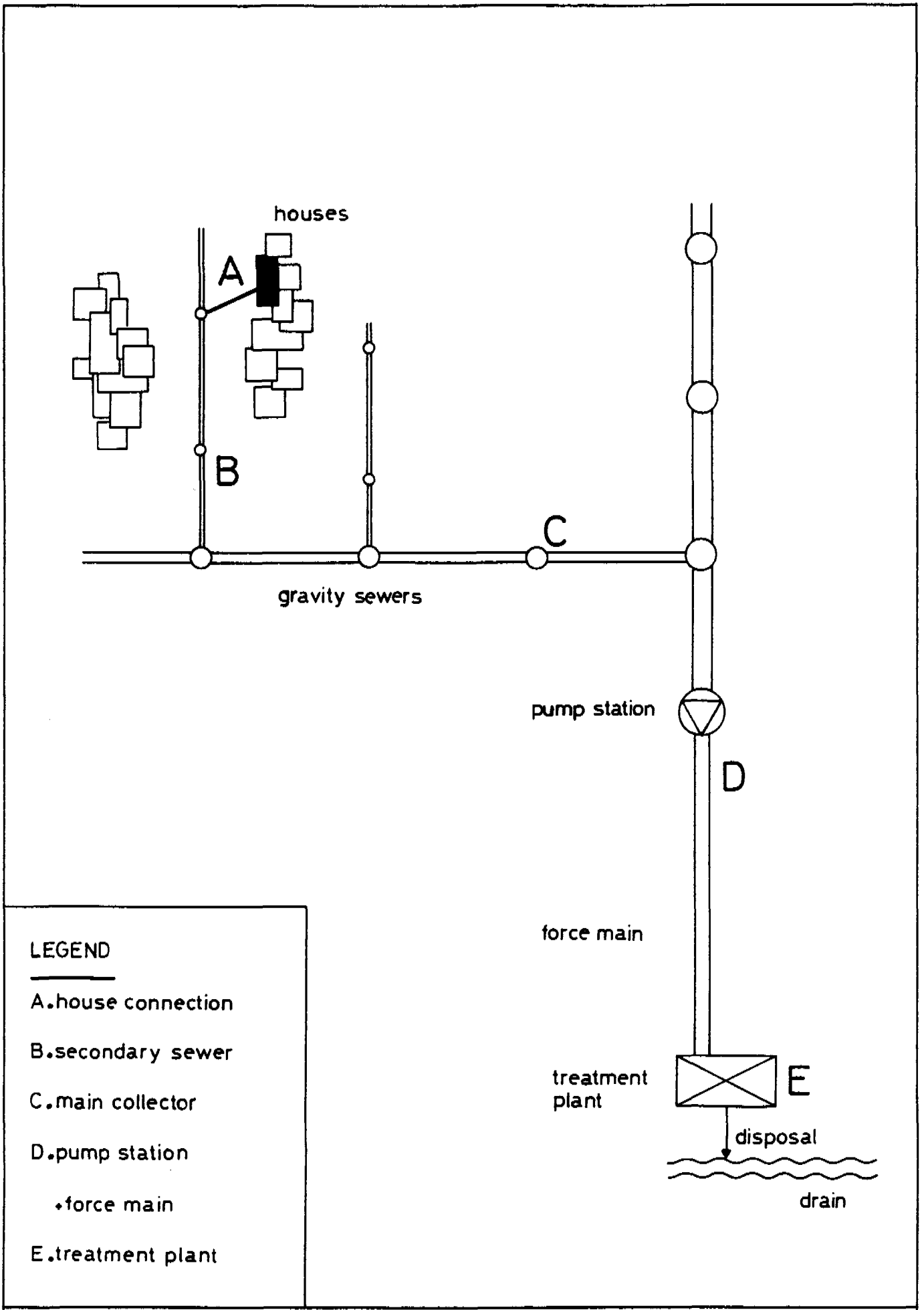


Figure 3.1. Components of a sewerage system

It is recommended to lay the secondary system at relatively shallow depth (with a minimum cover of 75 cm), but with sufficient gradient to allow self-cleaning, for the following reasons:

- Alleys between the houses in which the laterals are laid are narrow, which makes deep excavations difficult. Often, deep excavations are further hampered by high groundwater tables.
- Because the alleys are so narrow, the surface loading (i.e. the traffic) is low and there is no need for a thick soil cover.
- By laying the pipes between the houses at shallow depths, the main collector system need not be too deep either.

Small bore sewers are not recommended, although initial savings could be made on the construction (lower gradients, shallower depths). Interceptors (which are conditional for small bore sewers and which are expensive) near the houses are not advisable. Desludging of the interceptors (also expensive) would still be required. And it would be difficult to prevent individual households from connecting their toilet directly to the sewer, thereby jeopardizing the functioning of the small bore sewer system.

Main collector system

The main collector system will be of the conventional type. The design of the system shall take into consideration:

- NOPWASD design criteria and the Egyptian code of specifications (which of course applies to all construction works).
- Flexibility in lay-out and design, to allow for future population growth, urbanisation, increasing population densities (multi-storey buildings) and increase in domestic water consumption.
- Maximum use of the topographic situation, to avoid deep excavations and pumping stations.

Conveyance system

The conveyance system transports the sewage from the collection system to the treatment plant. The system typically consists of a pump station and force main. Designs are in accordance with NOPWASD criteria.

3.2.3 Wastewater treatment plants

Three aspects are important with regard to the planning of wastewater treatment plants:
a) location;
b) size (capacity);
c) technology.

Location of the treatment plants

Site selection for treatment plants is subject to the following considerations:

- central location with regard to the towns and villages which will use the plant,
- flow and use of the surface water (drain), receiving the effluent of the treatment plant,
- downhill of the collection system, to make optimum use of the topography,
- prevailing wind direction, to minimise nuisance from bad smell (these last two considerations are often contradictory in Fayoum).

Capacity of treatment plants; centralisation

The total population of approximately 1.5 million people in Fayoum lives in 37 municipalities (Local Units), 157 attached villages and 1600 hamlets. It will be clear that combining the wastewater treatment for several villages in one central plant has advantages, which can be summarised as follows:

- Manageability: a few larger treatment plants are easier to manage than many small ones. Experiences in Damietta Governorate show the difficulties involved in the operation of many small plants.
- Economies of scale: both construction and operation costs per-inhabitant-served of large plants are lower than for small plants.
  These savings will partly be off-set by the higher costs of pump stations and force mains.
- Environmental protection: effluent control can be realized more effectively at a few plants. And the provision of tertiary treatment (polishing of the effluent) is more economical at larger plants. Water pollution can therefore be mitigated more effectively.

Centralised wastewater treatment for clusters of towns and villages is recommended, and forms a basic element of this masterplan. The extent to which clustering is possible determines the required capacities of the wastewater treatment plants. The issue is elaborated in chapter 5.

Selection of the treatment technology

There are two major considerations in the selection of types of sewage treatment plants.

- Degree of treatment

Depending on volumes of wastewater and the allowable pollution of the receiving surface water, the required degree of treatment is determined in accordance with Law 48, 1982. For smaller treatment plants a lower quality of the effluent than for large treatment plants can usually be accepted, while meeting the same water quality standards for the receiving drain.

- Cost of Treatment

In the selection of alternative systems for sewage treatment the following parameters will normally be considered: investment cost, availability of land, cost of operation and maintenance, and the manageability of the plant.

The designs - and therewith technology choice - of most larger treatment plants that are to be constructed in Fayoum in the short and medium term have already been made (oxidation ditches, trickling filters and extended aeration). Smaller plants which may serve smaller villages as an intermediate solution will be of the "lagoon" type.
This masterplan does therefore not include an indepth assessment on technology choices. However, a listing of treatment options is presented in annex B.2.

3.3 INTERMEDIATE OPTIONS / THE MODULAR SEWER SYSTEM

The previous section presented the conventional solution for wastewater disposal: sewerage and sewage treatment. Section 3.4 will present on-site disposal alternatives.

From cost comparisons and considering the technical limitations to the various on-site alternatives (which are discussed in section 3.4) it becomes clear that some form of piped sewer system is to be preferred on technical grounds for most villages in Fayoum.

A low cost, intermediate option is discussed below. This option will solve the primary problem: the improvement of the health conditions in and around houses. The second objective - prevention of environmental pollution in compliance with Law 48,1982 - can not be met immediately but in a later stage.

The proposed system is known as the modular approach to piped sewerage. A village is divided into independently discharging sewer areas called modules. Each module is provided with a sewer system.

- In Step-1 of the implementation approach, a module discharges its wastewater to a drain outside the village.

- In Step-2, all modules in a village are connected by collector sewers and the wastewater is discharged to a small treatment near the village, the so-called local treatment.

- In Step-3, a number of villages is provided with pumping stations and force mains that bring all wastewater to a central plant for treatment.

Figure 3.2 illustrates the modular approach.

Ultimately - when step 3 is realised (after 10-20 years) - a conventional sewer system with treatment has been constructed. However, by phasing implementation and ensuring (modular approach) that all elements of a previous step can be used fully in the ensuing step, a cost effective system has been achieved that - already in its first phase -

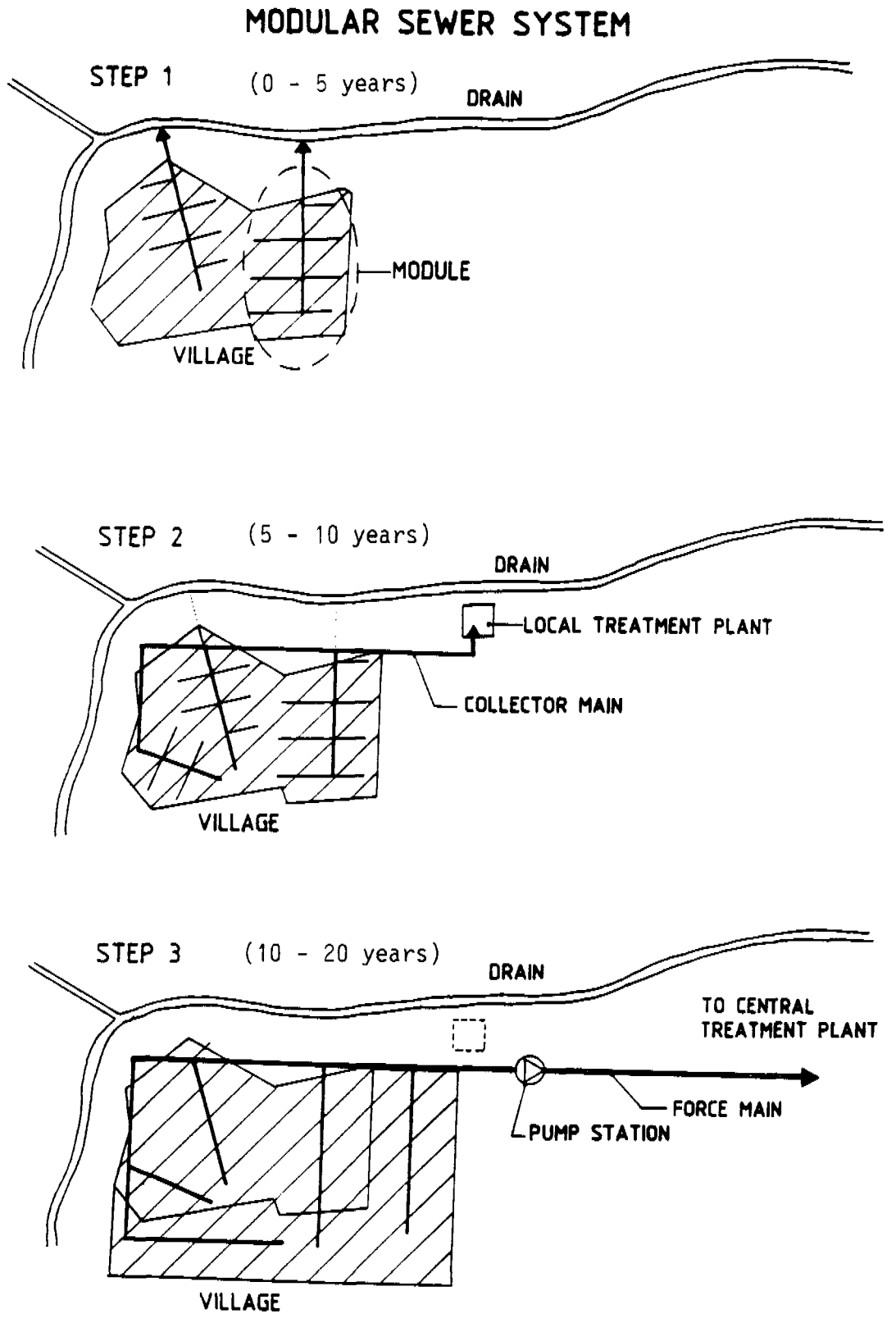


Figure 3.2. Staged Development of Modular Sewer Systems

considerably improves the living conditions in a village without using excessive funds.

The modular approach allows the construction of relatively cheap local treatment facilities for the current and near future population. By the time large overhaul is required and substantial extensions are needed to cover the increased population, a change to a more economical central treatment is possible, again without destroying previous investments.

The approach is flexible in the sense that two steps can be implemented simultaneously. If, for example, environmental protection requires so, steps 1 and 2 can be executed at the same time. In other cases, where local treatment would be relatively expensive, step 2 may be omitted and the sewer system can be connected immediately to the central treatment plant.

The cost of Step 1 of the modular system is approximately equal to the cost of a secondary sewer system plus half the cost of the main collection system.

If step 2, i.e. local treatment of the effluent before disposal in a drain, is required, several options are possible. Treatment in lagoons (including anaerobic and facultative ponds) provides a good quality effluent but is still relatively expensive (see section 3.5). An alternative is a large septic tank, serving 500 to 2,500 people, to which an "anaerobic upflow filter" is attached. Considerable improvement of the effluent quality can be achieved. More details about the technologies are provided in annex B.2.

3.4 ON-SITE SANITATION

3.4.1 Technical options

Ezbah's and smaller villages will not be covered by any piped sewer system in the medium or longer term. Any improvement of the sanitary condition can only be sought on-site.

There are two basic restrictions to the construction of cess pits: generally low infiltration capacities of the soils and high groundwater tables. In addition, little space is available near the houses. Only in smaller Ezbah's sufficient open area can be found.

Where households use little water (from public taps), small volumes of wastewater are generated. Because of these small volumes, infiltration in the soil is still a feasible option. In the Fayoum, cess pits can only cope with black wastewater.
In areas where the soil conditions allow so, improvements in the present cess pit can be found in dividing the functions of sludge collection and infiltration of the fluid in two separate pits.

In areas with high groundwater tables but good infiltration capacities, shallow infiltration beds may be applied. But these require large areas.

Studies indicate that the most favourable conditions can be found in the central area of the Fayoum depression (ref. 3), where the alluvial fan starts to dip steeply towards Lake

Qarun, as shown in the map of figure 3.3. The map is a combination of information on soil permeability and groundwater levels. See also annex B.4.

Below, four technical options are presented. a) Dry pit latrine; b) Double leaching pit; c) Septic tank; d) Vault. Figure 3.4 illustrates the different technologies.

Dry pit latrine

The lowest-cost solution, that suits the needs of low-density, rural and in general poor communities is the dry pit latrine. Because the toilet is placed directly above the pit, hardly any water is required for flushing. Low groundwater tables and good infiltration capacities of the soil are prerequisites. Sullage normally can not be disposed in the pit latrine to preserve the proper functioning of the pit. Although providing minimal convenience, this option means a major improvement in public health conditions as the faecal/oral infection chain is broken by keeping faecal matter out of the reach of people and flies.

Double leaching, water seal pit latrine

If families prefer to have the toilet inside the house, an off-set double leaching pit latrine is a good option. More water is required for flushing than for the dry pit latrine. The pit has a higher infiltration capacity because two pits are operated in turn (one after the other) for a one year period. The sludge in the pit not in use will dry during that period and will be bacteriologically safe. The owner can excavate the dried sludge by himself.

Unfortunately, because infiltration characteristics in the Fayoum depression are poor for the major part of the area, both above described technologies have limited opportunities. It implies that, even if the wastewater is initially collected on-site, the residues have to be collected and disposed of off-site. There are two options:

Septic tank

A septic tank is a closed tank that collects solid matter and decreases its volume during a biodegradation process. The overflowing excess water infiltrates in a soak-away pit or drainbed. The solid matter has to be collected from the tank - with a vacuum truck - once every one to three years depending on the size of the tank.
Because of high groundwater levels and generally poor infiltration rates in Fayoum, septic tanks with soak pits can be used only occasionally, and the effluent should be discharged through a pipe into a nearby drain, causing pollution. If water pollution is not acceptable, or where there simply is no nearby drain, only one on-site alternative remains: the vault.

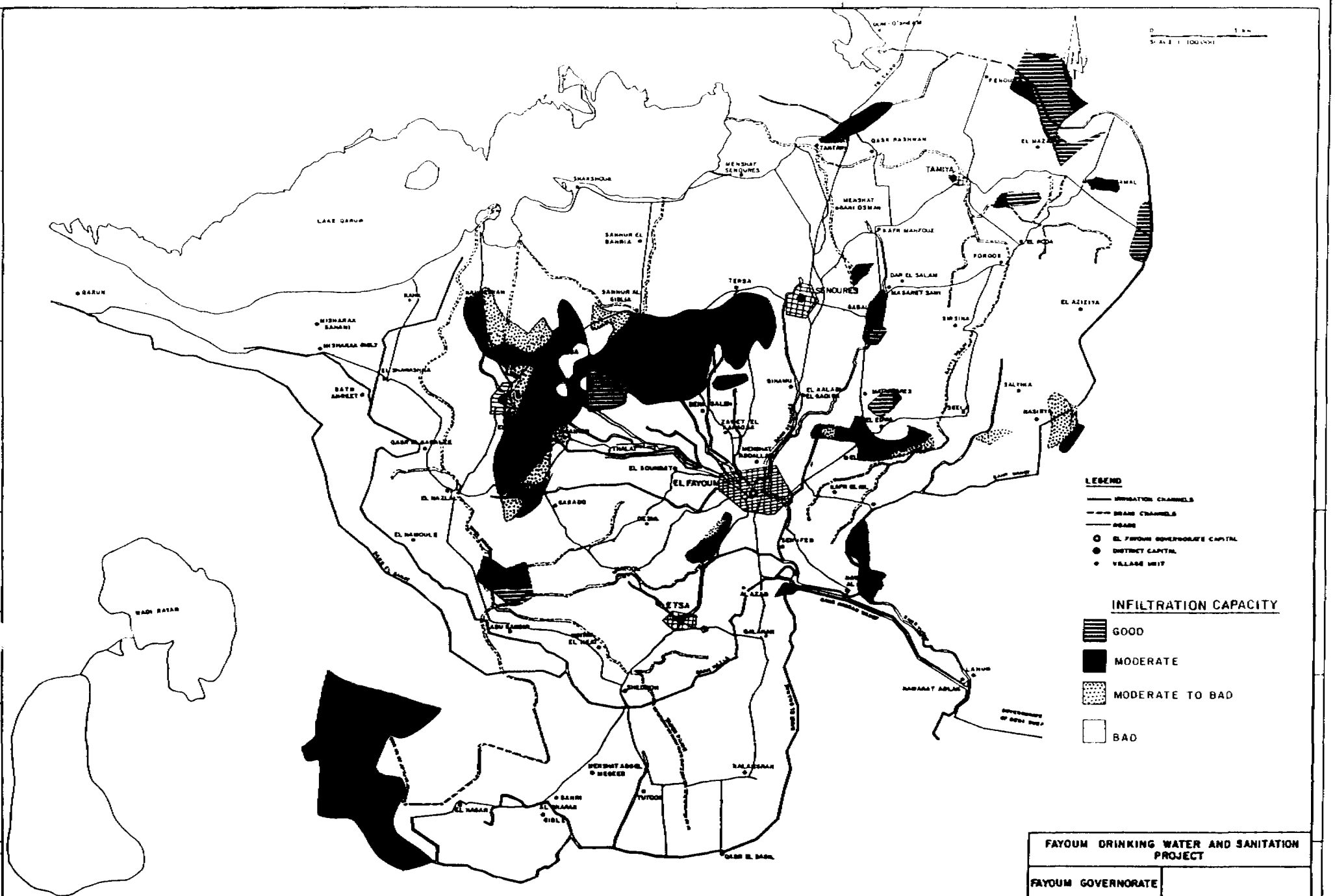


Figure 3.3. Zones with good to moderate infiltration capacities (based on ref. 3).

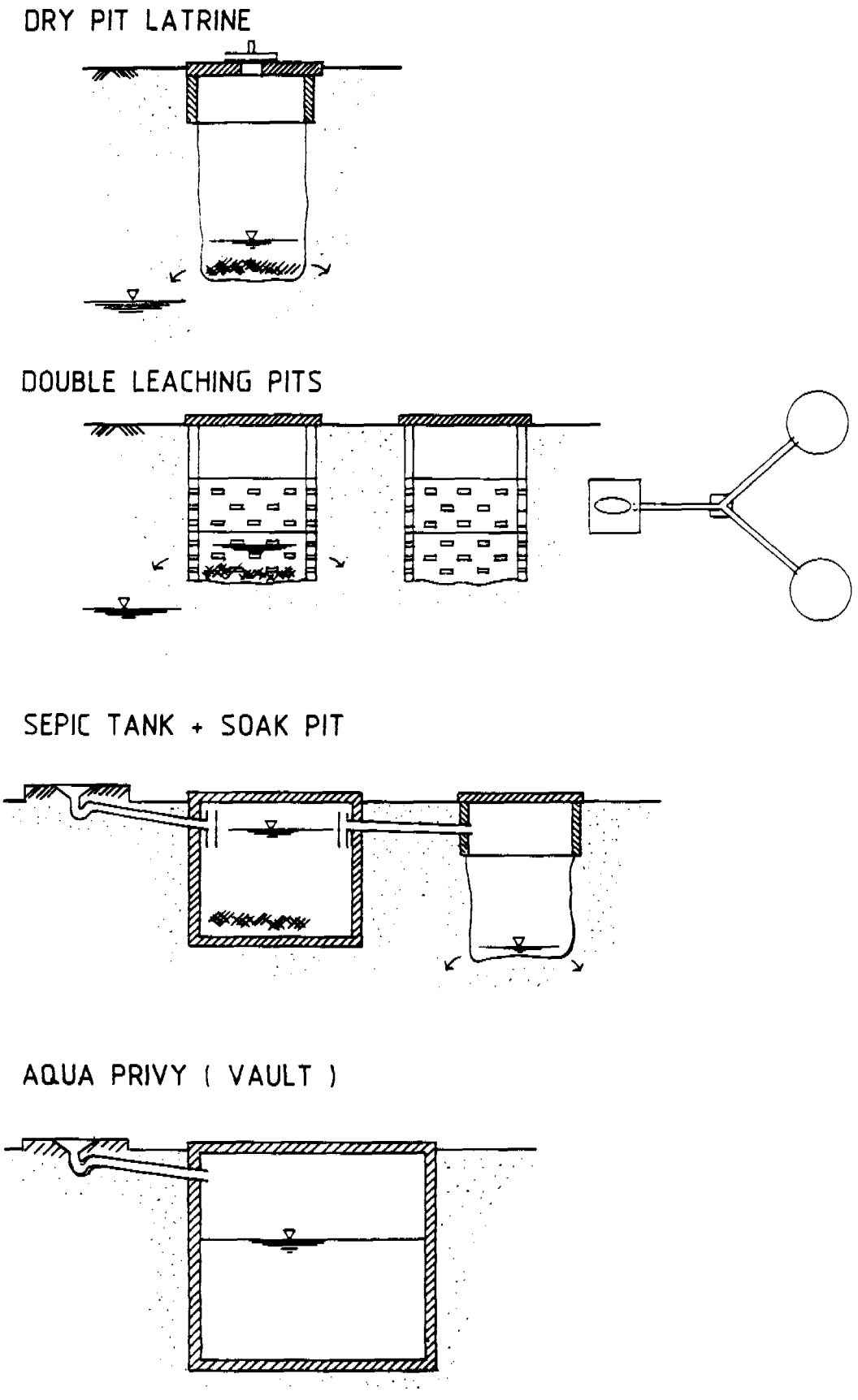


Figure 3.4. Technical options on-site sanitation

Aqua privy or vault

An aqua privy or vault is a closed water-tight tank without overflow. The tank has to be emptied frequently (every 2 to 6 months) and is therefore rather expensive in its use. It is the best technically feasible on-site technology for most of the Fayoum, considering the limitations of the earlier three options.

3.4.2 Collection and disposal of sludge from cess pits and vaults

Some 40% of the population have cess pits or vaults. In towns and larger villages where sewerage will be introduced, these private facilities will gradually be phased-out. But in villages and ezbah's which won't have sewerage in the near future, they will continue to serve large proportions of the population.

De-sludging services

Desludging services have to be provided for these on-site facilities. Considering the current type of on-site facilities (mainly badly functioning cess pits), one vacuum truck (of 6 to 8 m^3 capacity) may serve around 5,000 people.

The requirements for vacuum trucks may be reduced by alterations in the design of the cess pits. A separation of the functions of settlement of solids and percolation (as in a septic tank + soak pit) will reduce the frequency of de-sludging and therewith the need for vacuum trucks.

Vacuum trucks of smaller sizes than the current ones, such as tractors with small trailers are required to serve houses in narrow roads and alleys.

Sludge disposal

Technical options for the environmentally sound disposal of the contents of vacuum trucks are the following:

1. on-land disposal, preferably in the desert,
2. treatment in special plants, before disposal in surface water (drains),
3. composting together with solid waste,
4. treatment in sewage treatment plants.

On-land disposal in the desert is only financially possible if hauling distances are not too large. The option can therefore only be applied for villages along the fringes of the Fayoum depression. Measures to contain the disposed sludge at a controlled and sanitary safe location are required.

The construction and operation of special treatment plants for the sludge is probably not feasible because of the high costs. Composting together with solid waste does not seem a practical option either as long as solid waste collection and disposal is not sufficiently organised. On the longer term, when the reuse of solid waste becomes feasible, the option could be considered.

The disposal of the sludge in conventional sewage treatment plants is a viable option. In the coming years several treatment plants will be constructed scattered over the Governorate. The option is recommended as a medium term solution.

When this option is applied, this should be incorporated in the design criteria of these conventional treatment plants to cope with the generally high BOD and SS concentrations of the septage.

3.5 UNIT PRICES OF WASTEWATER INFRASTRUCTURE

Tables 3.1, 3.2 and 3.3 summarise costs of components of wastewater infrastructure. Annex B.3 provides more detailed information on prices.

Table 3.1. Unit costs of wastewater infrastructure; sewerage and sewage treatment - 1992 prices

	INVESTMENTS			O & M
COMPONENT	Unit	Cost/unit (LE)	Cost/cap. (LE/cap)	Cost/cap. per year (LE/cap)
House connection	one	150	25	
Secondary sewers	ha	48,000	120	1.50
Collection system	ha	32,000	80	0.75
Pump station and main (4km)	15000PE	1,230,000	80	2.90
Treatment Plant (trickling filter)	40000PE	5,400,000	135	5.00
TOTAL			440	10.15

The costs of sewer systems are based on preliminary designs made for two villages in Fayoum by the FaDWS project (ref. 5). The costs of treatment plants, pump stations and force mains are based on recent data from actual designs (NOPWASD/ECG).

The prices for pump stations / force mains are average figures for an installation with a capacity to serve 15,000 people and with a main length of 4 kilometres. Actual prices vary significantly with variations in these two parameters. The prices for the treatment plant are also average figures for a 2-stage/recirculation type trickling filter of 40,000 PE capacity.

Table 3.2. Unit costs of wastewater infrastructure; modular sewerage - 1992 prices

		INVESTMENTS		O & M
COMPONENT	Unit	Cost/unit (LE)	Cost/cap. (LE/cap)	Cost/cap. per year (LE/cap)
STEP ONE (sewers only)				
House connection	one	150	25	-
Sewer system	ha	64,000	160	1.88
Sub Total Step 1			185	1.88
STEP ONE+TWO (local treatment)				
Sub-total Step 1			185	1.88
Sewage lift station	2000 PE	36,000	18	0.75
Septic tank + upflow filter	2000 PE	25,000	13	2.50
Sub Total Step 2			216	5.13
STEP ONE+TWO (local treatment)				
Sub-total Step 1			185	1.88
Pump station + main (1km)	5000 PE	210,000	42	1.50
Lagoons (anaer. + facult.ponds)	5000 PE	550,000	110	6.00
Sub Total Step 2			337	9.38

For the modular sewerage option (table 3.2) two alternatives for step 2 (local treatment) are given. The choice depends on population served and environmental impact. As can be noted, the per capita cost of local treatment is similar to that of central treatment, because the population served is less (no economy of scale).

The prices for on-site facilities (table 3.3) are for one family latrines (6 persons).
O & M costs for on-site facilities are for de-sludging only. Basis is the real cost of desludging (estimated at LE 45.- per trip) which includes O & M and depreciation of the vehicles and costs of disposal.

Table 3.3. Unit costs of wastewater infrastructure; on-site sanitation - 1992 prices

	INVESTMENTS			O & M
COMPONENT	Unit	Cost/unit (LE)	Cost/cap. (LE/cap)	Cost/cap. per year (LE/cap)
Dry pit latrine	one	105	18	
Double leaching pit	,,	685	114	
Septic tank (excl.soak pit)	,,	615	103	3.00 (#)
Aqua privy (vault) (6 m^3)	,,	1270	212	30.00 (#)
squatting plate	,,	200	33	
soak pit	,,	165	28	
De-sludging (vacuum) trucks				
- for septic tanks;	50,000 PE	75,000	1.5	2.67
- for vaults	5,000 PE	75,000	15	26.67

(#) for desludging, LE 45.00 per trip, which includes cost of disposal

CHAPTER 4

NEEDS ASSESSMENT

4.1 OBJECTIVES

4.1.1 National objectives and policies

The national target for sanitation is that all secondary towns (i.e. Markaz or district capitals) are to be fully covered by sewerage in the year 2000. There are no specific targets for village sanitation.

In the light of this target, NOPWASD has developed plans for the construction of wastewater treatment plants in 118 towns and larger villages all over Egypt during the coming 5 years. Eight of these plants are planned in the Fayoum. The realisation of these plans would - as far as sewage treatment is concerned - already exceed the year 2000 target.

4.1.2 General requirements

General requirements call for improvements in sanitation infrastructure for the entire population of the Fayoum in a sustainable manner. Given the high cost of sewerage and sewage treatment, alternative (and lower cost) technologies are considered in order to serve larger groups of people.

4.1.3 General objectives

The present poor condition of wastewater disposal is a major contributor to the poor sanitary situation in the Fayoum and a direct hazard to public health.

The *primary objective* of better wastewater disposal is the improvement of the sanitary condition inside residential areas; i.e. to avoid direct contact with the waste by the residents.

On-site disposal satisfies this objective, because groundwater is not used in the Fayoum. But given the soil conditions, trouble-free application is only possible in limited areas. Piped disposal into drains and other surface water is a technically better alternative.

Surface waters are extensively used by the population; not only as source of domestic water (washing of dishes and clothes) but also for agriculture. Uncontrolled disposal of concentrations of wastewater flows on these drains could lead to unacceptable high pollution levels.

Therefore, the *second objective* of improved wastewater disposal is the prevention of excessive pollution of surface waters, which might occur due to increased sewerage.

Treatment of the wastewater before disposal is necessary in most cases.

The wastewater masterplan has to strike an acceptable balance between investments in sewer systems on the one hand (primary objective) and investments in pollution control measures for surface waters on the other hand (second objective).

Below, targets are set for various settlement classes based on the expected population in the coming years. Section 4.6 gives an estimate of required investments upto the year 2020.

4.2 POPULATION TO BE SERVED

Reference is made to the population forecast presented in the water supply masterplan (Volume II). An intermediate scenario for population growth has been considered, in which the yearly growth rates will decrease from the present 3% to 1.5% towards the year 2020. As a result the year 2020 population will reach 3.4 million. Population growth is assumed to be distributed equally over the various areas.

In 2020, the population is expected to be distributed over towns and villages as shown in table 4.1. The towns and larger villages which are expected to grow over 20,000 inhabitants are listed in table 4.2. Annex A.1 provides the population projections of all administrative units.

Table 4.1. Population Distribution Fayoum; year 2020

Area	Population range	No. of Villages	Total population
Fayoum City	469,000	1	469,000
Markaz Capitals	60,000-120,000	4	323,000
Larger Villages (*)	>30,000	23	928,000
Medium Size Villages (*)	20,000-30,000	23	562,000
Medium Size Villages (*)	15,000-20,000	21	362,000
Small Villages (*)	<15,000	90	771,000
TOTAL		162	3,415,000

(*) note: these cover the entire administrative area (local unit or attached village) and include hamlets where in average 25 % of the population lives.

The map of figure 4.1 shows the location of the towns and larger villages.

Table 4.2. Projection of population in main towns and villages (1992-2020)

Code		Town/Village	1992	2000	2010	2020
F		FAYOUM CITY	255,406	318,857	398,312	469,130
	1	SEELA	14,257	17,799	22,235	26,188
	4	EL EDWA	14,913	18,618	23,257	27,392
	5	El Amirryah	11,673	14,573	18,204	21,441
	12	EL LAHUN	11,301	14,109	17,625	20,758
	29	Hawaret El Makta'a	13,463	16,807	20,995	24,728
	33	ZAWET EL KARADSA	14,077	17,575	21,954	25,858
	35	Beni Salih	15,909	19,861	24,811	29,222
T	1	TAMIYA	35,047	43,754	54,657	64,375
	2	QASR RASHWAN	26,701	33,334	41,641	49,044
	4	Fenous	14,932	18,642	23,287	27,427
	5	MENSHAT EL GAMAL	21,409	26,727	33,387	39,323
	8	El Mazattli	10,985	13,714	17,131	20,177
	9	EL RODA	16,975	21,192	26,473	31,179
	15	DAR EL SALAM	14,235	17,771	22,199	26,146
S	1	SENOURES	66,152	82,587	103,166	121,509
	2	MATARTARES	18,832	23,510	29,368	34,590
	7	BIHAMU	12,138	15,153	18,930	22,295
	9	El Ka'abi El Gadida	11,412	14,247	17,797	20,961
	10	MENSHAT BENI OSMAN	11,419	14,256	17,808	20,974
	12	Menshat Tantawi	13,392	16,719	20,885	24,598
	13	SANHOR AL QIBLIA	33,060	41,273	51,558	60,725
	14	Sanhor El Bahria	11,481	14,333	17,905	21,088
	16	FIDIMIN	28,157	35,152	43,912	51,719
	19	TERSA	16,077	20,071	25,072	29,530
	25	Naqalifa	14,822	18,504	23,115	27,225
I	1	IBSHWAY	41,518	51,832	64,748	76,260
	2	KHAK	21,587	26,950	33,666	39,652
	5	El Kaleedyah	16,409	20,485	25,590	30,140
	6	EL SHAWASHNA	20,571	25,681	32,081	37,784
	7	El Misharak Qibly	19,985	24,949	31,167	36,708
	9	Batn Ahreet	17,023	21,252	26,547	31,267
	11	EL AQAMIEN	26,503	33,087	41,332	48,681
	12	El Nasaryah	17,798	22,220	27,757	32,692
	13	TOUBHAR	21,979	27,440	34,277	40,372
	15	ABOKSAH	19,271	24,059	30,054	35,398
	20	Shakshouk	14,018	17,500	21,861	25,747
	22	EL NAZLA	14,145	17,659	22,059	25,981
	24	Qasr El Gabalee	18,146	22,654	28,299	33,330
	25	EL HAMOULEE	11,679	14,580	18,214	21,452
	29	QARUN	33,218	41,471	51,805	61,015
	30	Senarou Qiblia	14,748	18,411	22,999	27,088
E	1	ETSA	33,161	41,399	51,715	60,910
	2	TUTOON	25,748	32,145	40,155	47,294
	9	QALAMSHAH	21,597	26,962	33,681	39,669
	11	Qasr El Basil	17,605	21,979	27,456	32,337
	12	GHARAK GIBLI	12,797	15,976	19,958	23,506
	13	El Gharak Bahri	17,617	21,994	27,475	32,359
	15	Menshat Abd El Megeed	12,122	15,134	18,905	22,266
	16	GARADO	18,849	23,532	29,396	34,623
	19	MINYA EL HEAT	26,428	32,993	41,215	48,542

*) Code numbers were assigned to all villages to facilitate cross-reference

**) Village names in uppercase represent Local Units

4.3 COST COMPARISON OF TECHNOLOGIES

It has already been stated several times that on-site disposal of wastewater into the soil is hardly possible in the Fayoum. The wastewater has in most cases to be evacuated out of the residential areas, either by vacuum trucks (as for septic tanks and vaults) or through pipes (as in a sewer system).

Hauling of the wastewater by trucks is expensive. Table 4.3. compares the costs of wastewater technologies, which shows that - in terms of yearly O&M costs and irrespective of who pays for these - vaults are more expensive than any form of sewerage. It means that, because a vault is the only technically feasible but least affordable on-site option in most regions of the governorate, the targets will necessarily contain a large sewerage component. On the other hand low-cost alternatives for vaults should be developed.

Table 4.3. Wastewater technologies: Financial comparison

Technology	Investment cost (LE/cap)	Yearly O&M cost (LE/cap)
Dry pit/double pit	18 - 114	-
Septic tank and soak pit	136	3.00
Modular sewerage, step 1 only	185	1.88
Aqua privy (vault)	212	30.00
Modular sewerage, step 1 + 2	216	5.13
Full scale sewerage and treatment	440	10.15

(see also paragraph 3.5)

4.4 WASTEWATER TARGETS

The three principal technical options - sewerage and sewage treatment, modular sewer systems and on-site sanitation - will be applied under different conditions.

For the various categories of settlements - i.e. markaz capitals, larger and smaller villages - targets have been set for future service levels by one of the three principal options. These targets, which are shown in table 4.4, require some further explanation.

4.4.1 Sewerage and sewage treatment

Large settlements will - in principle - have the highest priority for full scale sewerage. Any programme for sewerage and sewage treatment will first address these settlements.

Actual priorities for sewerage will depend on several criteria of which population size is only one. Smaller villages may be included in a sewerage programme when environmental conditions dictate this, or because of touristic or economic importance. We will elaborate on priority setting in section 4.5.

Table 4.4. Wastewater coverage targets in percentage of population

Town/Village Population Class	1992	2000	2010	2020
SEWERAGE AND SEWAGE TREATMENT				
Markaz capitals		60%	80%	95%
> 30,000		50%	60%	70%
20 - 30,000			30%	70%
15 - 20,000				35%
< 15,000				
MODULAR SEWERAGE				
Markaz capitals	40%			
> 30,000	20%			
20 - 30,000	5%	25%	30%	
15 - 20,000	3%	13%	30%	35%
< 15,000	1%			18%
TOTAL SEWERAGE				
Overall	10%	20%	40%	60%
ON-SITE SANITATION				
Overall	40%	40%	40%	40%
NO FACILITIES				
Overall	50%	40%	20%	0%

The feasibility of a system also depends on whether the users can afford to pay for the cost of at least operation and maintenance. The per capita cost of a full-scale sewer system is high and, depending on the degree of cost recovery the government wants to realise, will form a restriction on its financial feasibility. In chapter 8 this issue will be further dealt with.

The target for the year 2000 is to have sewerage and sewage treatment systems in place for the Markaz capitals and some of the largest villages, as already laid down in plans of NOPWASD.

In that same year, some smaller villages where the priority for sewer systems is high - and where it is environmentally acceptable - may be served by a modular system (i.e. without or with partial treatment).

The percentages-coverage indicate that not the entire area of the respective towns and villages will be served by a sewer network. Even in larger villages people may live too far from a sewer line to be connected, or might be unable to pay for the facility. Ezbah's - their population being included in the population statistics of the administrative units - will in principle not be covered either.

After the year 2000, gradually more villages will be covered with sewer systems. It must be realised that - in the course of time - a specific village will gradually move into a higher population class.

In subsequent target years, modular systems will be upgraded to full-scale sewerage and sewage treatment.

The target for 2020 has been set at a nearly full coverage by sewer systems of all villages larger than 15,000 inhabitants. Most of these villages will then also be connected to a treatment plant. As a result, projects in approximately 90 localities should have been executed in 2020.

4.4.2 On-site sanitation

General

Present wastewater disposal is predominantly on-site. In the villages limited disposal through groundwater lowering systems takes place at present, which are ranked under Modular Sewerage in table 4.4. Nearly half the present population does not have any facility at all.

In 2020, about 40% of the population, living mainly in hamlets and small villages, but also in the lower income areas of towns, will not yet be served by sewerage. Where soil conditions allow so, pit latrines will be an affordable technology for these people (see section 3.5). In other areas, the only technical appropriate option in most cases will be the relatively expensive vaults.

This means that, in order to attain the target of full coverage of 40% of the population with on-site sanitation, a special programme has to be developed.

Structural requirements

Given the poor infiltration characteristics of the soils in the Fayoum, only relatively expensive on-site facilities can be applied. In most cases all the waste (solids and liquid) needs to be evacuated by vacuum trucks - such as for vaults. Only in the few areas with more favourable soil conditions on-site disposal of the liquid portion of the waste in soak pits may be applied - such as with septic tanks - which will considerably reduce desludging requirements.

Because vaults are relatively expensive, especially in terms of operation (desludging) costs, they are affordable only for the small high income class. It implies that cheaper solutions have to be offered, even when these are technically or environmentally less appropriate.

For people with a house connection for drinking water, a septic tank with an overflow pipe into a nearby drain is an alternative (if a drain is available). The investment is similar to that of a vault, but desludging costs are considerably lower. From an environmental point of view, the option is only acceptable in small settlements and with larger drains. Direct disposal from the toilet to a drain (without passing through a septic tank) should be discouraged.

People will tend to choose the alternative with the lowest construction cost; i.e. a simple pit latrine. However, in high groundwater areas these are technically not possible (the pits will be permanently filled with water). In areas with low soil permeability, the pits will function as a vault (i.e. the wastewater will not infiltrate in the soil). Frequent desludging is then required. A double-pit latrine does not function better in these areas, and is therefore not a good alternative for the single pit in areas with low soil permeability.

The possibilities for low cost technically feasible solutions are limited. This is especially so for people belonging to the lowest income groups and living in areas with high groundwater tables and/or low soil permeability. Technical innovations to the single pit latrine to comply with the soil conditions may be sought along two lines:

1) At high groundwater tables: adjusting the design of the pit to prevent ingress of groundwater.

2) At lower groundwater tables but in soils with low permeability: the use of two non-lined pits in series. The first pit would retain part of the solids (as in a septic tank) and the second pit would function as a cess pit. Infiltration into the soil from this second pit is expected to be better than from a conventional "dry" pit.

It is necessary to execute a pilot programme in which different technical solutions (such as the two suggested above) are tested under the various soil conditions. The objective would be to find a most cost effective design, in which there is a balance between construction and operation (i.e. desludging) costs.

Whatever on-site alternative is chosen, the desludging costs will ultimately determine the financial feasibility. It implies that, when a large coverage is to be aimed at, these services should not only be considerably expanded, but also be provided at affordable fees.

Table 4.5. summarises the fields of action with regard to on-site sanitation. It considers the limitations caused by the generally high groundwater tables and low soil permeability and provides a link with the service level for water supply.

Table 4.5. Actions for improvements in on-site sanitation

Target groups according to:		
Water supply facility	Wastewater facility	Recommended action
1. Public tap	No facility	Improve public tap service promote pit latrine provide desludging services
2. Public tap	Pit latrine	Improve public tap service improve desludging services
3. House connection	No facility	Promote septic tank and cess pit or vault provide desludging services
4. House connection	Pit latrine	Promote septic tank and cess pit or vault Improve desludging services
5. House connection	Pipe to drain	Promote septic tank provide desludging services
6. House connections	Vault	improve desludging services

Promotion of on-site facilities

The construction of on-site sanitation facilities is the responsibility of individual households. With the objective to improve the public health conditions, the government can stimulate households to construct sanitary safe latrines. Such a programme shall take into consideration the differences in target groups as indicated in table 4.5.

Promotion activities for on-site sanitation are strongly attached to information or educational activities with regard to the use of latrines and water, and are linked with more general health and hygiene issues at household level. The responsibility for such activities lies mainly with the Department of Health. A further elaboration of a possible set-up and arrangement of a combined latrine promotion and hygiene education programme is a priority follow-up activity to this masterplan.

Desludging services

To provide adequate desludging services to households with cess pits, vaults and septic tanks (some 1.2 million people in 2020), a fleet of 200 to 300 vacuum trucks is required. It goes without saying that the efficient operation of such a large fleet requires proper management and the availability of an adequate operational budget.

Treatment of the collected sludge before disposal, preferably at the central wastewater treatment plants, is necessary.

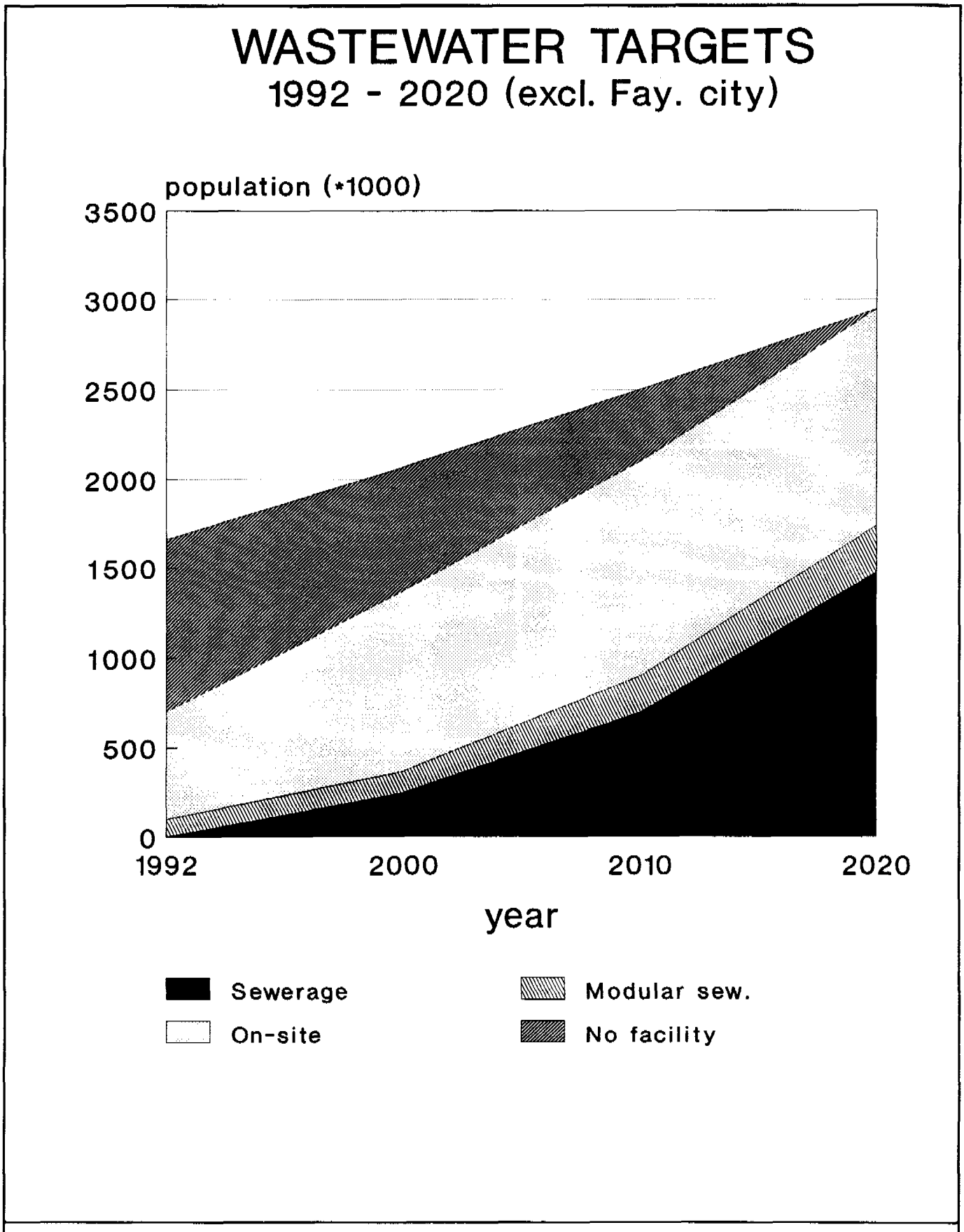


Figure 4.2. Wastewater targets (exlcuding Fayoum City)

4.4.3 Target population served (year 2020)

Table 4.6 summarises the year 2020 targets, which are graphically shown in figure 4.2.

Table 4.6 Wastewater coverage targets in population served - year 2020

Town/Village Class	Number of Settlements	Total Population	Sewerage & Treatment	Modular Sewerage	On-Site
Markaz cap.	4	323,000	95%	0%	5%
> 40,000	8	407,000	70%	0%	30%
30 - 40,000	15	521,000	70%	0%	30%
20 - 30,000	23	562,000	70%	0%	30%
15 - 20,000	21	362,000	35%	35%	30%
< 15,000	90	771,000	0%	18%	82%
Totals	161	2,946,000	1,477,000	262,000	1,208,000

(excluding Fayoum City)

4.5 PRIORITY RANKING FOR SEWER SYSTEMS

A prioritisation for sewer systems in the towns and villages in Fayoum has been made. The exercise has been done for all towns and villages with a population of over 15,000 in 2020. The approach and methodology applied are based on a LD-II/USAID report on strategic planning (ref 6).

4.5.1 Methodology

The prioritisation is based on five parameters, i.e.:

1. Population size
2. Water service level
3. Regional importance
4. Socio-economic development
5. Environmental pollution

Where possible, existing statistics were used to quantify the different parameters. By using existing statistics and applying a more "subjective' method for parameters for which no statistics are available, a fair ranking is achieved.

The following methodology was applied:

- For each of the five parameters, statistical data were collected which gave a good presentation of that parameter.
- If no data were available, each village was classified in a category by a panel consisting of staff from El Azab and the Sanitation Department.
- Each village received a mark for each of the parameters. Marks ranging from 0 to 10 were given, where a high mark indicates a high need for a sewer system.

- A weighing was made of the relative importance of each of the parameters.

The weighed average of the "marks" given for the different parameters determined the ranking of each town and village on the priority list.

4.5.2 The parameters

Population size

The population size is assumed to present the physical development of the town or village. Each town/village is marked between 0 and 10, with a "0" for the smallest village and a "10" for the largest town (Senoures).

The physical development of a village or town could also be represented by public facilities such as numbers and types of schools and lengths of paved roads. The premise is made that there is a correlation between these facilities and the number of inhabitants.

Water service level

Water service level can be represented by several indicators such as coverage with house connections, pressure in the distribution system and continuity in water supply. It is assumed that the coverage with house connections represents the water service level adequately. The "mark" for this parameter varies from "0" for no-house connections to "10" for full coverage.

Regional importance

The regional importance of a town or village can in the first place be measured from its administrative status, and is marked accordingly: a "10" for Markaz capitals, a "7" for a Local Unit and a "3" for attached villages. Further refinement has been made by considering the economic importance of the locality, such as for villages located in touristic areas.

Socio-economic development

This parameter represents the affordability of the population of the town or village to bear the costs of a sewer network. Households served by a sewer system will be required to pay fees for operation and maintenance costs and - in a later stage - depreciation of the capital investments.

Each locality is classified by the panel based on their knowledge of the economic situation in the Governorate. A high mark is awarded to a town or village which is relatively prosperous.

Environmental condition

The parameter describes the environmental condition inside the town and village; a condition which can be improved by a sewer system.

Most prominent in the Fayoum is the problem with high groundwater tables and impermeable soils, which frustrates the functioning of cess pits. In areas where these conditions are prevalent the need for sewer systems is urgent.

Two indicators are used: the drainage condition and soil types. These indicators are correlated to each other. Information was obtained from maps provided by the Fayoum Irrigation Department. The towns and villages were classified with a high mark for a locality in a problem area.

4.5.3 Weighing

For every town and village, marks have been given for each of the five parameters. And for each locality, the weighed average of the marks are calculated by giving higher weights to relatively more important parameters.

The following weighing-factors have been applied:

Population size	40 %
Water service level	20 %
Regional importance	5 %
Socio-economic development	15 %
Environmental condition	20 %

Annex B.4 presents a more detailed description of the prioritisation exercise. The results are summarised in table 4.7 which shows the top-30 towns and villages in need of a sewerage system.

4.6 REQUIRED INVESTMENTS, YEAR 2020

A summary of the unit costs of sanitation components was provided in section 3.5. Consequently, an assessment can be made of investment requirements to meet the coverage targets of table 4.5. The requirements are summarised in table 4.8.

At 1992 prices the total capital value of investments in sewerage systems would amount to LE 700 million, of which roughly 94% on the account of the government and 6% on the account of the population (mainly for house connections).

Table 4.7. Priority Ranking for Sewerage

RANK	CODE	TOWN/VILLAGE	POPULATION year 1992
1	S01	Senoures	66,152
2	T01	Tamiya	35,047
3	I01	Ibshway	41,518
4	S13	Sanhur	33,060
5	E01	Etsa	33,161
6	E02	Tutoon	25,748
7	T02	Qasr Rashwan	26,701
8	S16	Fidimin	28,157
9	E19	Minya El Heat	26,428
10	I11	El Agamien	26,503
11	S02	Matartaris	18,832
12	E09	Qalamshah	21,597
13	T09	El Roda	16,975
14	T15	Dar El Salam	14,235
15	S19	Tersa	16,077
16	E16	Garado	18,849
17	F04	El Edwa	14,913
18	F35	Beni Saleh	15,909
19	I13	Toubhar	21,979
20	S25	Naqalifah	14,822
21	F01	Seela	14,257
22	I20	Shakshouk	14,018
23	I02	Kahk	21,587
24	I22	El Nazla	14,145
25	T16	Masarat Sawi	10,698
26	S07	Bihamu	12,138
27	I15	Aboksah	19,271
28	F34	Menshat Abdallah	10,023
29	F38	Senufer	8,536
30	E15	Menshat Abdel Megeed	12,122

Table 4.8. Investments required (year 2020) - 1992 price level *) in million LE

TYPE	Inv. per cap (LE)	Pop. to be served	Total investment	Contribution Government	Contribution Population
Full sewerage	440	1,480,000	650	613	37
Modular sewerage	185	260,000	50	43.5	6.5
On site sanitation	± 100	1,200,000	120	-	120
Vacuum trucks	pm	pm	120	20	-

*) excluding Fayoum City

These values are indicative only. The configuration of clusters of towns and villages - and therewith the capacities of treatment plants and the lengths of force mains - influences the costs significantly. A small portion of the total capital requirements have already been paid or are committed under current NOPWASD programmes.

On-site sanitation would be predominantly community self-help. The 200,000 on-site private facilities which are estimated to be required in 2020 represent a value of approximately LE 120 million.

In addition to community self-help the Government would have to invest in some 250 vacuum trucks for desludging, representing an investment of LE 20 million.

CHAPTER 5

CLUSTERING FOR WASTEWATER TREATMENT

5.1 INTRODUCTION

The need for sewerage - and therewith for sewage treatment - is great. Targets for the year 2020 were determined in chapter 4 and they aim to cover 1.7 million people, living in 70 towns and villages of over 15,000 inhabitants. Providing all the settlements with separate treatment plants would be impractical. The combination of sewage treatment at a limited number of centrally located plants for clusters of towns and villages is therefore recommended. This chapter deals with the concept of clustering for wastewater treatment.

Clustering has several advantages:

- Manageability: a few large treatment plants are easier to manage than many small ones. Presently, there is little experience at governorate level with the operation of wastewater treatment plants; a situation which can only change gradually and with great effort.

- Economies of scale: both construction and operation costs of fewer - although larger - plants will be less than those of many small plants.

- Environmental protection: effluent control can be realised more effectively at a few plants. And the provision of tertiary treatment (polishing of the effluent) is more economical at larger plants. Water pollution can therefore be mitigated more effectively.

However, to transport wastewater from villages to a central treatment plant, the construction (and operation) of pump stations and force mains is required. These are expensive pieces of infrastructure. When the distances to the central plant become too large, the costs will become prohibitive and will off-set the financial advantages of central treatment.

There will therefore be a limit to the distance over which wastewater can be transported economically. In other words, there will be an upper limit to the size of a cluster of towns and villages.

There are several aspects which play a role in the optimisation of the size of clusters for sewage treatment, such as:

- The cost of pump stations, force mains and treatment plants, both in terms of investment and operation and maintenance costs.
- The presence of already existing infrastructure, or of plans to build these.

- The geography of the area, or spatial distribution of the villages. It would be more expensive to connect one isolated village than a group of small villages which could share the force main.
- The treatment technology. Different technologies (with different costs) may be chosen in relation to population-served and effluent quality requirements.
- Phasing of the various infrastructure components. If there is a possibility to delay large investments, this would influence the financial cost of different options.
- The manageability of many or fewer plants.

In section 5.2 a summary is presented of a comparative costs analysis to determine the optimum size of a cluster. The result is a general "rule" regarding the distance over which it is financially justified to connect a village of given size to a central treatment plant. A full report is presented in annex B.5. An alternative approach, in which engineering, economics and environmental pollution are integrated in the clustering-model, is described in reference 7.

In section 5.3, the present situation (existence of plants or plans to construct them) is examined and clusters are formed around these plants, based on the general rules developed in section 5.2. Details of this exercise are presented in annex B.6.

5.2 SEPARATE VERSUS CENTRALISED TREATMENT

In this paragraph the maximum distance between a village and a central treatment plant is determined, at which it is still cheaper to transport the wastewater from that village to the central plant, as compared to treatment near the village itself.

5.2.1 Elements of the analysis

As a basis, the case of a town (or large village) with one nearby smaller village is considered. Two alternatives, which are illustrated in figure 5.1, have been compared financially.

Alternative 1: Both the town and village have their own separate treatment plants.

Alternative 2: The sewage from the village is transported by a pump station and force main to the central treatment plant near the town.

The following variables are considered:

a. The distance between the central treatment plant and the village.

b. The size of the town. Larger towns require larger treatment plants, which will be cheaper per population equivalent (PE) served.

c. The size of the village. The same economies-of-scale applies, also with regard to the pump station and force main.

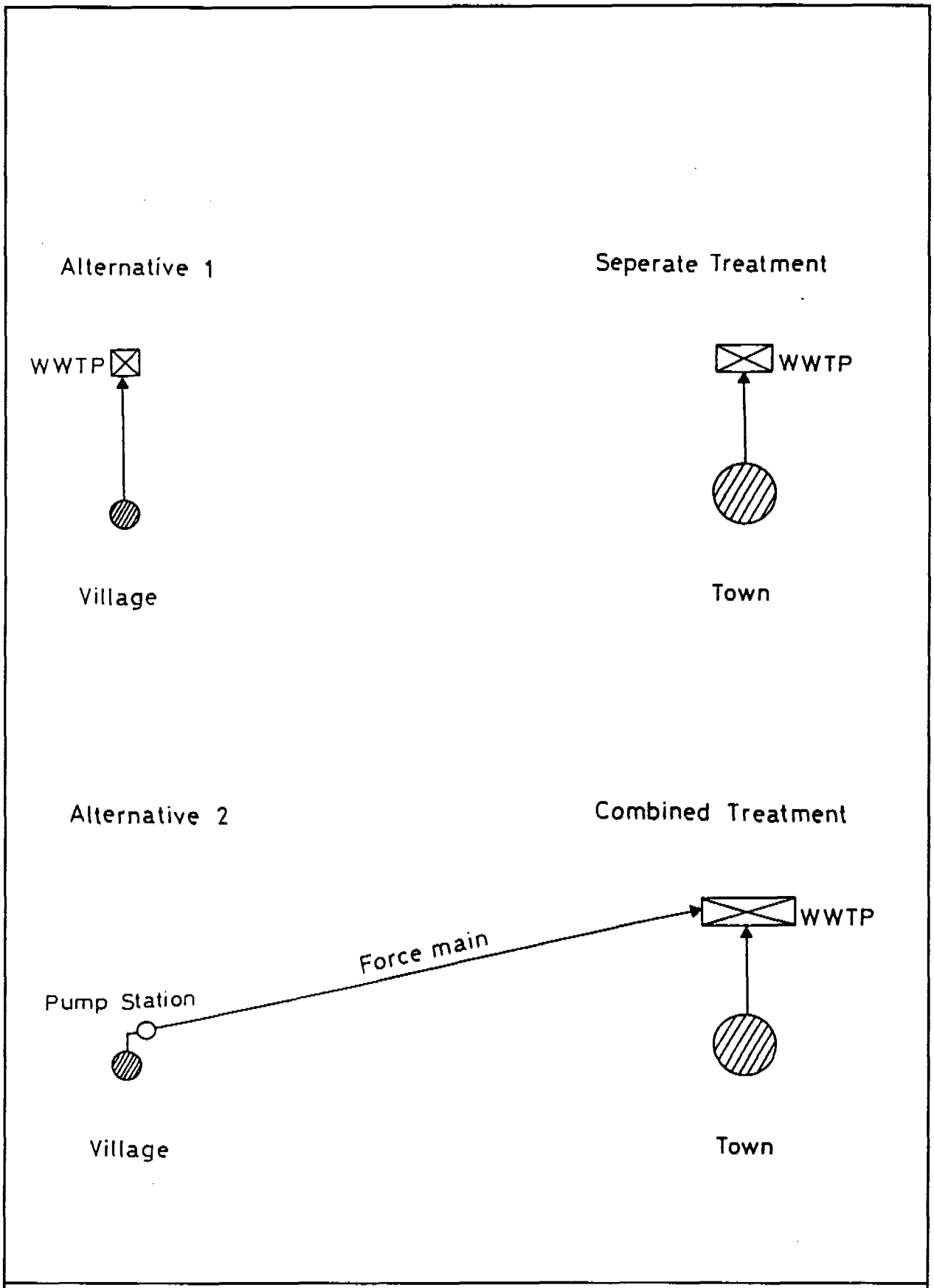


Figure 5.1. Basis of the clustering analysis separate versus combined treatment

The financial comparison is made for both investment and operation costs. Costs of the infrastructure components are presented in annex B.3.

A number of pre-conditions and considerations are applied:

- The cost of a sewerage - or wastewater collection - system for a given town or village size is equal for both alternatives and is not included in the analysis.

- For the treatment plants at both the town and village, the same effluent quality shall apply. Initially the same treatment technology is assumed for all cases.

- Later, alternative treatment technologies have also been examined. For example at small villages, relatively cheap technologies (such as anaerobic and facultative ponds) can be applied which give good effluent quality, but which are not feasible for towns because of excessive land requirements.

- Tests are also made on the effect of topography (electricity costs increase considerably when sewage has to be pumped up-hill). This aspect plays an important role in the final formation of clusters.

The basic analysis for one town and one village will result in general rules regarding optimum distances as a function of town and villages size.

- Finally the effect of groups of villages, situated close to each other, and the possibility to use pump stations of intermediate villages for sewage transport, has been examined.

5.2.2. Conclusion of the analysis

The analysis, which is presented in detailed in annex B.5, yields the following conclusions:

a. Wastewater can be transported economically - in terms of investment costs - over a distance of approximately 5 km.

b. This distance increases gradually when the central treatment plant becomes larger; to approximately 8 km for sizes of 75,000 PE. This effect is more pronounced for trickling filters than for oxidation ditches.

c. However, the operation cost of pumping stations becomes more expensive at these distances. The optimum distance in this respect is 4 to 5 km. The shorter distance applies when the village to-be-connected becomes larger.

d. It is effective to make use of the topography of the area. For larger villages (25,000 PE) the critical distance (in terms of operation costs) increases with one kilometre for every 10 meters of ground level difference. For smaller villages, this effect is less pronounced.

e. When an anaerobic - facultative pond system is an option for a small village, the economic distance to transport the wastewater is smaller; less than 5 km when investment costs are considered.

f. In terms of operation costs, it will always be more expensive to pump the wastewater to a central treatment plant than to treat it locally in a pond system. For small remote villages the anaerobic pond system is therefore to be preferred as an intermediate solution. On a longer term, centralisation is recommended considering the manageability.

g. The conclusions above also apply to groups of villages, where the wastewater could be pumped from one village to another and finally to a central treatment plant.

5.3 FORMATION OF CLUSTERS

5.3.1 Criteria for cluster formation

In this paragraph, the criteria which determine the layout of the clusters are summarised.

Existing and planned treatment plants

There are three existing wastewater treatment plants in the Fayoum: near Fayoum City at El Nazla and at Sanhur. The plant of Fayoum City is being extended. Two plants are under construction (Senoures and Ibshway). Seven others have been tendered and construction contracts have been awarded. Table 2.3 (chapter 2) summarised the situation. For the location of the plants, see figure 5.2. As much as possible, these plants are used as centres for the clusters.

Negotiations between the Governorate of Fayoum and NOPWASD have resulted in changes of the location of a few planned treatment plants to more favourable sites. Our analyses served as basis for these negotiations.

Targets for coverage with sewerage

The target for the year 2020 is set at a coverage with sewerage of nearly all villages with population sizes over 15,000 in that year.

The targets will be met in phases according to priorities which were determined in section 4.5. For this analysis it is assumed that in a first phase, the largest towns and villages will be covered; in later phases, smaller population centres will be included.

Phased implementation of sewerage in relation to clustering is important in two ways:

1. It will dictate the required size of the central treatment plants in the consecutive years.

2. It will determine whether it is economic to connect a far-off village to a central treatment plant in an early phase. The wastewater can only be pumped economically over a longer distance if this is done via other villages. These villages should then also have a sewer system. If these intermediate villages have a lower priority than the first village, it may be necessary to delay the construction of the force main to a later phase.

Geography and topography

The most important parameter for the formation of clusters is the distance between the towns, villages and central treatment plants. 5 kilometre is considered as the distance at which a village can always be connected to a central plant or to a nearby village. This distance increases to 8 kilometres when the central treatment plant becomes larger (75,000 PE and more).

The topography has not much influence on the construction cost of pump stations and force mains. But it is critical for operation costs, especially for larger capacity pump stations (50,000 PE). As much as possible the wastewater should be pumped downhill. In a few cases, gravity mains can be used.

5.3.2 Description of the clusters

All the towns and villages that will have more than 15,000 inhabitants in the year 2020 are included in the cluster formation. The areas are grouped into clusters which are formed using the above criteria. The locations of the clusters are shown in figure 5.3. Below we will discuss each cluster separately, providing a justification for its composition and size. More information is provided in annex B.6.

CLUSTER 01, Fayoum City

The existing treatment plant of Fayoum City is to serve the city and smaller villages in a radius of some 5 kilometres. Only the village of Hawaret El Makta'a is somewhat further away, but connection is justified considering the large capacity of the central plant.

CLUSTER 02, Lahun

Lahun is too far from cluster 01 to be included in it. A separate treatment facility is required. The facility may be combined with the plant for New Fayoum City. The development of this new town, which will be located on desert land south of the Bahr

Yusuf, is expected to start around the year 2000. The present plan for this new town includes a wastewater treatment plant.

CLUSTER 03, Tamiya

The planned treatment plant at Tamiya town can serve a large area in the north-east of the governorate.

The plant, which was originally planned south of the town, is relocated to the west. The plant can thus also serve Qasr Rashwan; a large village which has a high priority for sewerage. The separate treatment plant which was originally planned near Qasr Rashwan is no longer required and will be shifted to another cluster (Tutoon).

Villages like Fenous and Menshat El Gamal are rather distant (7.5 and 8 kilometres from Tamiya town), but the topography is advantageous (18 and 10 meter level difference).

Menshat Tantawi can be connected via Qasr Rashwan. Level difference is disadvantageous (-15 metres), but because of the short distance and small size of the village it is within acceptable limits.

The planned plant at Tamiya has sufficient capacity to serve the targeted population of the entire cluster well beyond the year 2000, when more villages (in addition to Tamiya and Qasr Rashwan) will be connected.

CLUSTER 04, Senoures

The treatment plant at Senoures is under construction. Because of the large capacity of the plant and its central location, the plant could serve a large cluster. Naqalifa and Tersa are included in the cluster, with a force main towards Senoures town. The wastewater has to be pumped uphill, however (-15 metres). The main between Naqalifa and Tersa can be operated by gravity.

Even villages far to the east (Seela) can be covered (with force mains via El Edwa and Matartaris). The relatively long force main between Matartaris and the central treatment plant at Senoures is justified because of the large capacity of the plant. In this configuration the plant could serve the targeted population upto the year 2007.

SUB - CLUSTER 04a, Matartaris-El Edwa

Two separate treatment plants are already planned in the east (Matartaris and El Edwa). It is proposed to at least cancel one of these plants. The remaining plant can temporarily serve both villages. At a later stage, when the plant reaches its capacity, it can be decided to connect the villages to the central plant at Senoures. Alternatively, the small plant at El Edwa or Matartaris could be extended in a second phase.

CLUSTER 05, Sanhur

The recently constructed plant at Sanhur can serve a small cluster, including Fidimin. Although a separate treatment plant is planned for Fidimin, it would be uneconomical to construct it. The wastewater from Fidimin can be transported to Sanhur by gravity, because of the large difference in elevation (23 metres) between the two villages. Operation cost will thus be minimal.

The capacity of the plant at Sanhur is sufficient to serve both villages (Sanhur and Fidimin) until the year 2000. Extension is required around that year, when also other villages in the cluster are to be connected.

CLUSTER 06, Shakshouk

This cluster comprises the village of Shakshouk and the tourist facilities along the lake. There are no plans for sewerage yet, but the priority may be high because of economic interests and protection of the lake shore from pollution.

CLUSTER 07, Ibshway

The treatment plant near Ibshway, of which the construction started recently, can serve a large area, including Aboksah in the north, El Nazla and El Hamoulee in the south-west and El Agamien, Toubhar and Desia in the east. In this configuration, the plant's capacity is sufficient upto the year 2007.

However, there is already a plant at El Nazla, which can serve this village upto 2000. After that year, when more treatment capacity is required, El Nazla (and El Hamoulee) can be connected to the central plant near Ibshway, although level differences are disadvantageous (-20 metres). As an alternative, the plant at El Nazla could be extended.

SUB-CLUSTER 07a, El Agamien

Within the large Ibshway-cluster a separate plant is planned for El Agamien. Although the construction of this plant would leave the Ibshway plant under-used for a long period (which is uneconomical), it has been decided not to relocate this plant. El Agamien thus forms a sub-cluster, including Toubhar and Desia.

CLUSTER 08, Kahk

Near Kahk there is no treatment plant planned yet. The area is too low to connect it to Ibshway (-40 metres level difference). A new plant near Kahk can serve this village, El Shawashna and neighbouring villages. The cluster has a low priority.

CLUSTER 09, Qarun

Qarun is situated in the extreme west of the governorate. Although the population of the local unit is large (over 30,000 at present), this population is distributed over many ezbah's. The main village is much smaller. The area has for this reason a relatively low priority for sewerage.

CLUSTER 10, Etsa

The planned treatment plant near Etsa has sufficient capacity to serve the population of the town and nearby El Heat Minya beyond the year 2010.

The plant was originally located at a site south-east of the town. Based on our analyses, NOPWASD has decided to relocate the plant towards the west along the El Wadi drain: closer to El Heat Minya and at a lower elevation.

CLUSTER 11, Tutoon

There is no treatment plant planned yet in this southern area of the governorate. The plant from Qasr Rashwan (superfluous in the Tamiya cluster) can be used here. A plant near Tutoon can also serve Kalamshah and Kasr El Basil, and El Gharak and El Hagar towards the west.

El Gharak Bahri shall be connected to the central plant via Menshat Abdel Megeed. However, the latter village has - in terms of population sizes - a lower priority than El Gharak Bahri. Depending on actual priorities, sewer systems in both villages have to be constructed simultaneously to economise the cost of the force mains, or El Gharak Bahri has to be provided temporarily with a separate treatment unit.

The villages in the west of the cluster have a lower elevation than Tutoon. It would, however, not be economic to locate the central treatment plant in the west. Tutoon and Kalamshah have a much higher priority for sewerage than the smaller villages in the west and the short term investments in a treatment plant is justified only when it is close to the sewered area.

CLUSTER 12, Industrial area of Qom Osheem

The Qom Osheem area in the north of the governorate is becoming an important industrial zone. A central wastewater treatment plant for this area is to be recommended. Depending on the nature of the individual industries to be established, the treatment plant can receive raw wastewater or pre-treated effluent from the industries.

CHAPTER 6

IMPLEMENTATION PROGRAMME, FIRST PHASE (2000)

6.1 INTRODUCTION

In chapter 4, targets were set for coverage by different sanitation technologies in 2020, and a sketch was made on how to reach these targets in a staged manner.

In this chapter the first phase of the staged plan is formulated in more detail with the objective to determine the required investments for that first phase. The first phase will cover the period upto 2000.

Pre-conditions for the formulation of the first phase investment plan are the following:

- Priorities for sewer systems in specific localities, depending on several factors such as population size, present water service level, socio-economic condition and environmental health situation, are determined in section 4.5.

- Ongoing and already committed works in the wastewater sector are integrated in the first phase plan.

- Based on the staged targets for sewerage, sewer systems will cover around 50% of the population in towns and larger villages by the end of the first phase. The total coverage will reach approximately 350,000 people distributed over some 20 to 25 localities.

- Priorities for sewage treatment will follow from the required coverage by sewer systems, possibilities for centralised treatment (in line with the recommendations on clusters for sewage treatment; see chapter 5), and minimising environmental pollution (i.e. contamination of surface waters).

- As an intermediate solution, modular sewerage can be applied in villages with a high priority for sewer systems but where the connection to a central treatment plant in an early phase would be too expensive.

- During the first phase, a start shall be made with a programme to improve on-site sanitation facilities.

- Desludging services shall be extended considerably in line with the targets set earlier.

6.2 ONGOING WASTEWATER PROJECTS

The ongoing and already committed projects in the wastewater sector can be summarised as shown in tables 6.1.a through 6.1.c.

Table 6.1.a. Projects already implemented (excluding Fayoum City)

RANK	CODE	TOWN/ VILLAGE	POPULATION		CAPITAL INVESTMENTS (mill.LE)				
			TOTAL 1992	SERVED 2000	H.CONN.	SEWERS	PS+FM	TREATMENT	TOTAL
4	S13	Sanhur	33,060				0.7	2.4	3.1
24	I22	El Nazla	14,145	8,830	0.2	1.8	0.5	1.4	3.9
		Totals:		8,830	0.2	1.8	1.2	3.8	7.0

note: capital investment values are FaDWS estimates; actual costs were different

Table 6.1.b. Projects being implemented and for which financing is arranged.

RANK	CODE	TOWN/ VILLAGE	POPULATION		CAPITAL INVESTMENTS (mill.LE)				
			TOTAL 1992	SERVED 2000	H.CONN.	SEWERS	PS+FM	TREATMENT	TOTAL
1	S01	Senoures	66,152	49,552	1.2	9.9	2.9	7.2	21.2
3	I01	Ibshway	41,518	31,099	0.8	6.2	1.8	4.7	13.5
4	S13	Sanhur	33,060	20,637	0.5	4.1	-	-	4.6
		Totals:		101,288	2.5	20.3	4.7	11.9	39.4

note: with treatment capacity sufficient to also serve high priority villages
note: capital investment values are FaDWS estimates; actual costs (of NOPWASD/USAID projects) are different

Table 6.1.c. Projects already committed, but for which financing arrangements are not clear.

RANK	CODE	TOWN/ VILLAGE	POPULATION		CAPITAL INVESTMENTS (mill.LE)				
			TOTAL 1992	SERVED 2000	H.CONN.	SEWERS	PS+FM	TREATMENT	TOTAL
2	T01	Tamiya	35,047	26,252	0.7	5.3	2.0	4.1	12.0
5	E01	Etsa	33,161	24,839	0.6	5.0	1.6	3.6	10.8
7	T02	Qasr Rashwan	26,701	16,667	0.4	3.3	1.4	at WWTP of Tamiya	5.2
8	S16	Fidimin	28,157	17,576	0.4	3.5	1.5	2.2	7.7
10	I11	El Agamien	26,503	16,544	0.4	3.3	1.3	3.6	8.6
11	S02	Matartaris	18,832	11,755	0.3	2.4	1.4	1.7	5.7
17	F04	El Edwa	14,913	9,309	0.2	1.9	1.0	1.5	4.6
		Totals:		122,943	3.1	24.6	10.2	16.7	54.6

note: with treatment capacity sufficient to also serve high priority villages
note: capital investment values are FaDWS estimates; actual costs (of NOPWASD/USAID projects) are different

The total capital investment of LE 54.6 million, mentioned in table 6.1.c, is an FaDWS estimate and represents the value of the works required to meet the year 2000 demands. Actual costs of the works differ because most of the works (especially those planned by NOPWASD) have a much larger capacity.

The design capacities of these plants are so large that in most cases, they will only be fully used after the year 2010. It is therefore strongly recommended to implement the works in stages in order to save on initial investments. Discussions between the Governorate and NOPWASD on this issue are in progress.

6.3 FIRST PHASE SEWERAGE PROJECTS

6.3.1 Sewer Systems

In addition to the projects already being implemented or committed, another 10 to 15 villages are in urgent need for sewer systems. Tables 6.2.a through 6.2.c list three groups of projects in order of priority. Reference is made to table 4.7 on priority ranking.

Table 6.2.a. High Priority Projects

RANK	CODE	TOWN/ VILLAGE	POPULATION		CAPITAL INVESTMENTS (mill.LE)				
			TOTAL 1992	SERVED 2000	H.CONN.	SEWERS	PS+FM	TREATMENT	TOTAL
6	E02	Tutoon	25,748	16,072	0.4	3.2	0.6	3.0 (*)	4.2
9	E19	Minya El Heat	26,428	16,497	0.4	3.3	0.7	at E01	4.4
12	E09	Qalamshah	21,597	13,481	0.3	2.7	1.6	at E02	4.6
13	T09	El Roda	16,975	10,596	0.3	2.1	1.3	at T01	3.7
15	S19	Tersa	16,077	10,035	0.3	2.0	1.5	at S01	3.8
16	E16	Garado	18,849	11,766	0.3	2.4	0.5	at I11	3.1
19	I13	Toubhar	21,979	13,720	0.3	2.7	1.7	at I11	4.8
20	S25	Naqalifah	14,822	9,252	0.2	1.9	0.7	at S01	2.8
		Totals:		101,419	2.5	20.3	8.6	3.0 (*)	34.4

note: (*) already committed WWTP, relocated from Qasr Rashwan

Table 6.2.b. Second Priority Projects

RANK	CODE	TOWN/ VILLAGE	POPULATION		CAPITAL INVESTMENTS (mill.LE)				
			TOTAL 1992	SERVED 2000	H.CONN.	SEWERS	PS+FM	TREATMENT	TOTAL
14	T15	Dar El (*) Salam	14,235	8,886	0.2	1.8	1.6	at S01	3.6
18	F35	Beni Saleh (*)	15,909	9,931	0.2	2.0	1.3	at S16	3.5
21	F01	Seela	14,257	8,899	0.2	1.8	1.4	at S02	3.4
22	I20	Shakshouk	14,018	8,750	0.2	1.8	1.2	2.3	5.5
23	I02	Kahk	21,587	13,475	0.3	2.7	1.0	2.9	6.9
25	T16	Masarat Sawi	10,698	6,678	0.2	1.3	0.9	at S01	2.4
		Totals:		56,619	1.4	11.3	7.4	5.2	25.3

(*) Dar El Salam and Beni Saleh which have a relatively high priority, are listed as 2nd priority projects because they are located far from the central treatment plant.

Table 6.2.c. Third Priority Projects

RANK	CODE	TOWN/ VILLAGE	POPULATION		CAPITAL INVESTMENTS (mill.LE)				
			TOTAL 1992	SERVED 2000	H.CONN.	SEWERS	PS+FM	TREATMENT	TOTAL
26	S07	Bihamu	12,138	7,577	0.2	1.5	0.8	at S01	2.5
27	I15	Aboksah	19,271	12,029	0.3	2.4	1.2	at I01	3.9
28	F34	Menshat Abdallah	10,023	6,257	0.2	1.3	0.8	at Fayoum	2.3
29	F38	Senufer	8,536	5,328	0.1	1.1	1.8	at Fayoum	3.0
30	E15	Menshat Abdel Megeed	12,122	7,567	0.2	1.5	2.0	at E02	3.7
		Totals:		38,757	1.0	7.8	6.6		15.4

It is proposed to place the list of high priority projects (table 6.2.a) in the first phase investment programme for realisation before the year 2000. The location of the projects is shown in figure 6.1.

To implement the high priority projects, an investment of LE 31.4 million is required in addition to the investments in the ongoing projects. This amount includes LE 2.5 million for house connections. Investments for the treatment plant in Tutoon are already committed under the ongoing NOPWASD programme.

6.3.2 Clusters for wastewater treatment

Wastewater treatment for (nearly) all the high priority villages will be covered in the ongoing sewerage projects, as is indicated in table 6.2.a. Only for Tutoon a new treatment plant is to be constructed. But the investments for this work is also already committed because the plant will be relocated from Fidemeen or Qasr Rashwan (NOPWASD).

The treatment plants of El Nazla and El Edwa/Matartaris will serve for an intermediate period only. When the capacity of the new plants are reached, it is recommended that no extensions are made but force mains are constructed in the second phase to the large central treatment plants (of Ibshway and Senoures respectively).

The locations of the treatment plants to be constructed in the first phase are shown in figure 6.1.

6.4 MODULAR SEWERAGE

The modular sewerage systems can be applied in smaller villages with a high priority for sewer networks, but which are located rather far from a central wastewater treatment plant. In cases where the village is located near a large drain, step 1 of the modular system can be applied (i.e. disposal without treatment). Where there is no large drain to receive the wastewater, primary treatment will be required (step 2 of the modular system). See also chapter 7 for the environmental assessment.

The villages with high priorities for sewer systems and eligible for a modular system are - provisionally - drawn from the "second priority list" (table 6.2.b). See also figure 6.1.

Table 6.3 below shows villages where modular sewerage can be applied. The sewer systems are assumed to be required in a limited area of the villages only, covering 25 % of the year 2000 population. In most of the villages simple wastewater treatment (step 2) is required, for which septic tanks/anaerobic upflow filters are proposed.

Table 6.3. Modular sewerage

RANK	CODE	TOWN/ VILLAGE	POPULATION		CAPITAL INVESTMENTS (mill.LE)				
			TOTAL 1992	SERVED 2000	H.CONN.	SEWERS	PS+FM	TREAT MENT	TOTAL
STEP 1 ONLY									
21	F01	Seela	14,257	4,450	0.11	0.71			0.82
STEP 1 AND 2									
14	T15	Dar El Salam	14,235	4,443	0.11	0.89		0.14	1.14
18	F35	Beni Saleh	15,909	4,965	0.12	0.79		0.15	1.07
22	I20	Shakshouk	14,018	4,375	0.11	0.70		0.13	0.94
23	I02	Kahk	21,587	6,737	0.17	1.08		0.21	1.45
25	T16	Masarat Sawi	10,698	3,339	0.08	0.53		0.10	0.72
		Totals:		28,310	0.71	4.71	0.00	0.73	6.14

To serve 28,000 people by these systems, an investment of LE 6.1 million is required (including LE 0.7 million for house connections).

6.5 ON-SITE SANITATION

To achieve the targets with regard to on-site sanitation (i.e. to reach a coverage of approximately 1.2 million people in the year 2020), an average of 10,000 new or improved latrines have to be constructed each year.

The construction of latrines is the responsibility of individual households. However, the Government can stimulate households to construct a sanitary safe latrine.

Hygiene Education Programme

Considering the strong relation with public health, and the socio-economic environment, it is recommended to formulate a health education programme in which sanitary health practices and the construction of safe toilets are incorporated.

The programme may include the following aspects:

- general hygiene practices in villages,
- most critical hazards to private and public health,
- possible ways to improve sanitary practices and public health,
- the role which improved human waste disposal can play in this improvement.
- consideration to incorporate the promotion of safe toilets by the construction of demonstration units.

The programme shall be implemented through the appropriate channels, which probably exist within the Department of Health. It is recommended that during the first phase, a health education programme is developed and implemented at pilot level. By the end of the first phase, full scale implementation should have started.

Testing on-site sanitation options

It is recommended that, in connection with the development of the hygiene education programme, a project is started to test alternative on-site sanitation technologies that are suitable for the soil condition in Fayoum and that meet the requirements of the lower income groups in the Governorate. The results of the tests shall be incorporated in the set-up of the hygiene education programme. This project might be implemented jointly by the Fayoum Sanitation Department, ORDEV and the Department of Health.

6.6 DESLUDGING SERVICES

To provide appropriate desludging services, the present fleet of vacuum trucks (an estimated total of 50 trucks, distributed over the four Markaz capitals and some local units) have to be expanded to a total of 100 to 200.

The target for the first phase may be set at doubling of the fleet to 100. This represents a total investment of LE 3.8 million.

Before new vacuum trucks are procured, the organisations that provide desludging services in the various towns need strengthening, with the objective to make more efficient use of the existing equipment.

6.7 SUMMARY OF INVESTMENT REQUIREMENTS, FIRST PHASE

A summary of the required investments to realise the first phase plan is given in table 6.4. The table does not include the costs related to technical assistance (TA) programmes for the development and strengthening of the implementing agencies. The scope of the programmes for agencies at governorate level are identified in chapter 8.

Table 6.4. First Phase Investment Programme (year 2000) (in million LE 1992 prices)

Description	Population to be served	Total Investment	Contribution Government	Contribution Population
Already committed sewerage projects (table 6.1.c)	123,000	54.6	51.5	3.1
New Sewerage Projects				
- high priority projects (table 6.2.a)	101,000	34.4	31.9	2.5
- modular sewerage (table 6.3)	28,000	6.1	5.4	0.7
On site sanitation	300,000	30.0	MOH *)	self help
Desludging services	p.m.	3.8	3.8	-

*) Ministry of Health promotion programme

CHAPTER 7

ENVIRONMENTAL IMPACT OF WASTEWATER PROJECTS

7.1 INTRODUCTION

As a part of the wastewater masterplan, an assessment is made of surface water quality aspects. The results of the study are presented in a separate FaDWS project report (ref. 3). Here we provide a summary and a further elaboration of that report.

Three types of target areas have been studied:
1) village environment,
2) five drainage areas,
3) Lake Qarun.

Furthermore, the specific impact of the proposed treatment plants and modular sewerage projects has been analyzed.

7.2 GENERAL CONCLUSIONS

7.2.1. Village environment

Public health and abatement of nuisance require sewage to be transported out of the residential areas. Only with adequate diluting capacity can it be discharged untreated into a nearby drain. Otherwise, further transport to a sewage treatment plant is necessary.

7.2.2 Drainage areas

Five drainage areas have been studied which are shown in figure 7.1. The main conclusions are:

- Treatment of the water from upstream villages along the Tagen-Wadi drain has a more significant positive impact than further downstream measures (i.e. Kalamshah and Tutoon as compared to El Nazla - area A).
- Along the small drains the discharges of upstream villages have a significant impact on the downstream water quality conditions (e.g. Sanhur - Kafr Abud, Naqalifa - Tersa - area B/D).
- Completion of the extension of the wastewater treatment plant of Fayoum City is of prime importance for the protection of the water quality of the Batts drain (area C).
- Treatment of wastewater from villages along the Batts drain, upstream of the large irrigation-reuse station near Tamiya is necessary to ensure a proper water quality of the reuse water (area C).
- Secondary treatment at the treatment plant of Senoures is required, as the discharge of the effluent will be upstream of that town (area E).

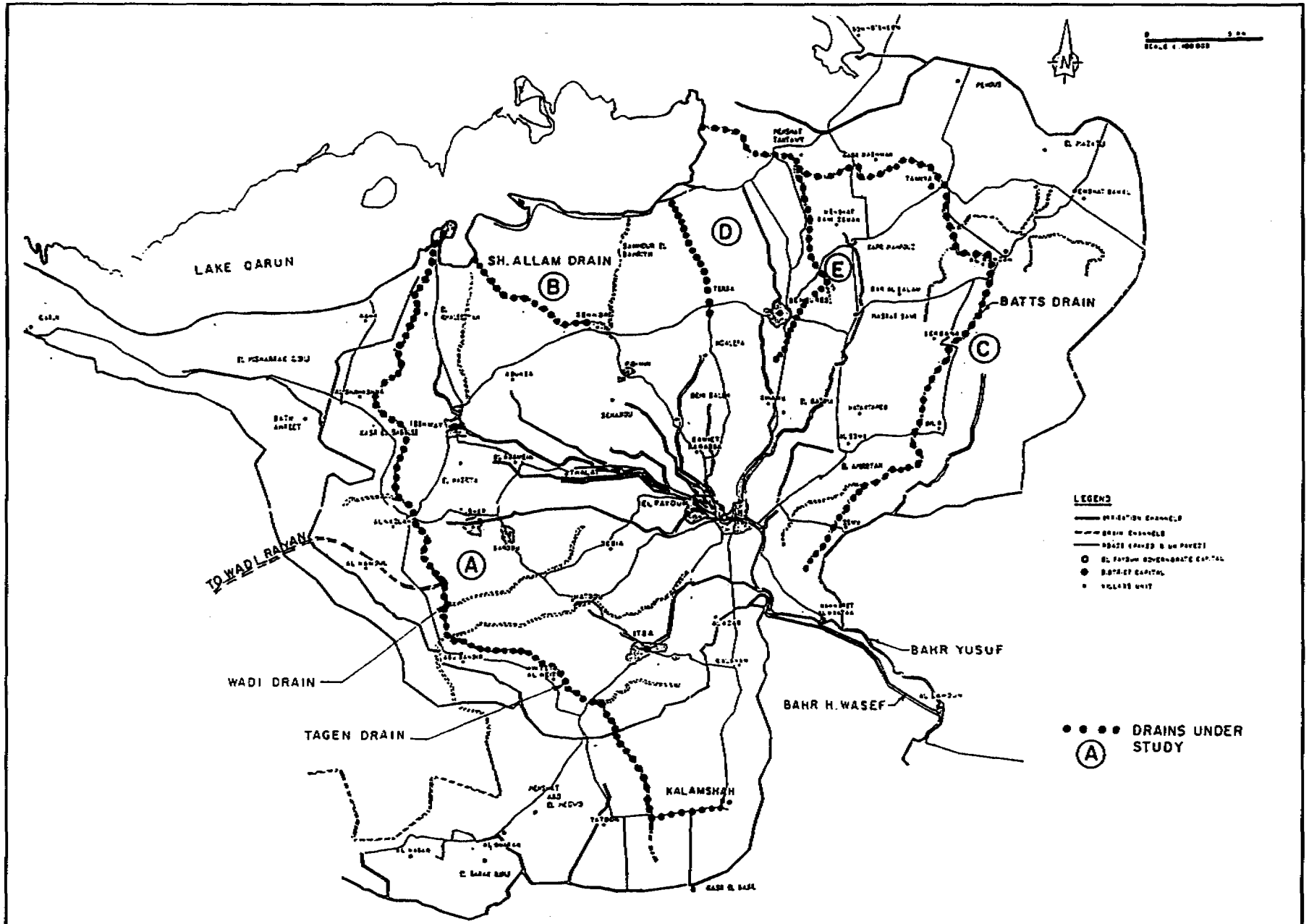


Figure 7.1. Five drainage areas, subject of environmental assessment

7.2.3. Lake Qarun

To protect recreational interests along Lake Qarun, villages on the lake's shore and near the mouth of the Batts drain should have sewage treatment.

Bacterial pollution, eutrophication and the fate of micropollutants in Lake Qarun should be further studied. The study should be integrated and address the impacts on the lake's ecology from water and sanitation developments and agriculture.

The environmental impact of the sub-projects of the first phase investment programme are discussed further in the following two paragraphs. The environmental implications of on-site sanitation are summarized in the last paragraph.

7.3 ENVIRONMENTAL IMPACT OF CENTRAL TREATMENT PLANTS

The recommendations with regard to the central treatment plants can be summarised as follows:

1. Treatment plant of Fayoum City (cluster 01)
   Although the effluent of the treatment plant is discharged on the large Batts drain, the wastewater volumes are so large that it dominates the water quality of the drain. Secondary (biological) treatment is of utmost importance. Tertiary treatment is strongly recommended for the medium term.
   In the first phase, no villages - additional to Fayoum City - will be connected to the plant.

2. Treatment plant of Tamiya (cluster 03)
   The plant (oxidation ditch) is situated near the tail end of the Batts drain, downstream of Tamiya town. Full treatment is not very important for the water quality of the drain. The (NOPWASD) plant will include secondary treatment which will adequately meet the environmental requirements.

3. Treatment plant of Senoures (cluster 04)
   The plant (surface aeration) is located at the head of a very small drain: hardly any dilution of the effluent will occur. Secondary treatment is a prerequisite and is included in the NOPWASD design. Tertiary treatment will be required on the medium term.

4. Treatment plant of Matartaris (cluster 04a)
   The plant (oxidation ditch) is located along a small tributary of the Batts drain (El Garan El Kabir drain/Goor El Mask), in which little dilution will occur. Secondary treatment is obligatory, which is included in the designs of the plant. From environmental point of view it is recommended not to expand the plant once its capacity is reached. Treatment of the waste in a large plant (at Senoures) is recommended.

5. Treatment plant of El Edwa (cluster 04a)
The plant (an anaerobic-facultative pond system) is situated along the larger Batts drain. The water quality in this drain is fully governed by the effluent of the large wastewater treatment plant of Fayoum City, some 7 km upstream. The effluent of the small El Edwa plant has a relatively small impact on the drain's water quality and future expensions of the plant with similar treatment technologies is allowable.

6. Treatment plant of Sanhur (cluster 05)
The plant (trickling filter) is located on a small tributary of the Sheikh El Allam drain. Downstream, the water is reused for irrigation. At present the plant provides primary treatment only. Implementation of the planned second stage of treatment (i.e. biological treatment) is urgently required.

7. Treatment plant of Fidimin (cluster 05a)
The plant (oxidation ditch) is also located along a small tributary of the Sheikh El Allam drain. The NOPWASD design includes secondary treatment which is adequate for the short term. Tertiary treatment shall be considered in the medium term.

8. Treatment plant of Shakshouk (cluster 06)
Construction of the plant is not (yet) included in the first phase. The plant will be located along a small drain close to Lake Qarun. Full treatment will be required to prevent pollution of the nearby touristic area.

9. Treatment plant of Ibshway (cluster 07)
The plant (trickling filter) is located along a small tributary of the large Wadi drain (distance 2 kilometres). Secondary treatment - which is included in the NOPWASD design - will meet the environmental requirements sufficiently.

10. Treatment plant of El Agamien (cluster 07a)
The plant (oxidation ditch) is also located along a tributary of the Wadi drain, but at a much larger distance (10 kilometres). Secondary treatment (included in the design) is a prerequisite. Tertiary treatment shall be considered in the medium term.

11. Treatment plant of Etsa (cluster 10)
The plant (oxidation ditch) is relocated close to the Wadi drain. Because dilution will be large, secondary treatment (which is included in the design) is sufficient for the longer term.

12. Treatment plant of Tutoon (cluster 11)
The Tagen drain, on which the plant's effluent will be discharged, has very long retention times in the stretch downstream of the plant. To avoid oxygen depletion, secondary treatment is a prerequisite. This step is included in the plant's design (oxidation ditch). Tertiary treatment shall be considered on a longer term.

7.4 ENVIRONMENTAL IMPACT OF MODULAR SEWERAGE PROJECTS

Villages eligible for modular sewerage are provisionally drawn from the "second priority list" for sewer systems (table 6.2.b). Here we provide the assessment of treatment requirements.

1. Dar El Salam
   The village is located on a small - 5 kilometre long - tributary of the Batts drain. The confluence is just upstream of the irrigation reuse station near Tamiya. The drain is too small to ensure sufficient dilution and treatment is therefore required.

2. Beni Saleh
   The village is located on a small drain which necessitates treatment.

3. Seela
   The village is close to the large Batts drain, well upstream of Tamiya town. As the treatment plant of Fayoum City dominates the water quality of the drain, treatment of wastewater from Seela does not have a high priority.

4. Shakshouk
   The village is situated on the shore of Lake Qarun close to the touristic area. Treatment is necessary.

5. Kahk
   The village is also close to Lake Qarun, but at a larger distance from the touristic area. Treatment is recommended.

6. Masarat Sawi
   The same conditions apply as for Dar El Salam. Treatment is required.

7.5 ENVIRONMENTAL IMPLICATIONS OF ON-SITE SANITATION

On-site sanitation can - if choosen and constructed appropriately - adequately improve the public health condition inside residential areas as it cuts the faecal/oral infection chain. Prerequisites are a good infiltration capacity of the soil, or adequate desludging services to evacuate the accumulated sludge and wastewater outside the residential boundaries. Pollution of groundwater from cess pits is not regarded as a serious impact, because it is not used as (drinking) water source.

Evacuation of wastewater from individual septic tanks through pipes into nearby drains is only acceptable for very small or isolated settlements, where the polluted drainwater cannot have a large impact on people.

Evacuation of wastewater by vacuum trucks has an indirect environmental impact, as the trucks' contents are emptied into agricultural drains. This practice contributes considerably to the water pollution of drains and the lake (there are more people served by vacuum trucks than people having a sewer connection) and shall be halted urgently.

As soon as more wastewater treatment plants come into operation the legislation which prohibits the disposal of vacuum truck sludge into drains, shall be enforced. Trucks shall only be allowed to empty their contents at treatment plants or into sewers connected to treatment plants. The construction of separate disposal and treatment facilities for vacuum trucks is not recommended.

CHAPTER 8

ORGANISATIONAL DEVELOPMENT AND COST RECOVERY

8.1 GENERAL

In this chapter the scope and division of responsibilities for the wastewater activities in Fayoum are outlined, as well as an organisational development programme to meet the institutional requirements of the year 2000.

First of all the adopted organisational model will be outlined with a brief description of responsibilities on each level. Secondly, the possibilities for cost recovery will be analyzed, and thirdly the organisational development plan is presented.

8.2 PROPOSED INSTITUTIONAL FRAMEWORK

8.2.1 General set-up for sewerage

Since 1991, Fayoum Governorate has a Sanitation Department, which for the time being directly resorts under the Governor. Besides Fayoum, there are 5 other Governorates which have established an organisation for wastewater handling (ref.8):

- Kafr El Sheikh assigned the entire wastewater function to its independent water and wastewater company;
- Damietta, Qalubiya and Beheira have Wastewater Departments in the Governorate that report to the Secretary General;
- South Sinai has a department for Water and Wastewater under the Secretary General.

The set up for Fayoum recommends the separate development of a Sanitation Department in the Governorate as a first step. The main reasons for NOT integrating the sanitation department in El Azab on the short term are the following:

- the organisational complexity would increase considerably;
- the water company should concentrate first on achieving cost recovery for its water supply operations. Adding the responsibility for wastewater to the company would absorb too much energy and efforts and moreover would increase the costs for O&M considerably. The sanitation sector needs still longterm Government subsidising, for the water sector on the other hand financial self reliance can be achieved on the short term (see water supply masterplan).

Cooperation and coordination between El Azab and the FSD is already being established in the framework of the ongoing Netherlands supported FaDWS project. At a later stage when the FSD has matured it may become integrated in the Water Company.

In Egypt, responsibilities for the O&M of sewage treatment plants and sewer systems lie with the municipalities. This set-up is based on the concept that each municipality or

Local Unit has its own waste water treatment plant. In Governorates where in rural areas sewerage and sewage treatment have been introduced, the responsible agency at Governorate level, like the FSD in Fayoum, provides some support but is not responsible.

Since in Fayoum clustering for wastewater treatment is recommended, the treatment plants are not serving just one municipality, while the service area may even extend beyond the Markaz boundary. It is therefore recommended to develop the FSD as the central managing agency for all the regional wastewater treatment plants in Fayoum. This is an equivalent set up to El Azab Water Works, which is responsible not only for the central treatment but also for another 17 compact units, spread all over the Governorate.

The responsibility for O&M should include the pump stations and Force Mains that run from the towns or villages to the regional treatment, but excludes the town or village sewer systems. O&M of sewers is a suitable responsibility for municipalities and Local Units, who could still receive initial guidance and technical support from the FSD, especially in the start-up phase.

Sewerage fees are recommended to be collected as a surcharge on the water bill (see 8.3), therefore El Azab needs to collect the fees on behalf of the FSD.

The general set-up as described above is pictured in the chart of figure 8.1.

8.2.2 Description of responsibilities for sewerage

The proposed division of the responsibilities for sewerage in the Governorate, based on the above set-up, are as follows (see also table 8.1):

Governorate level (FSD)

The responsibilities in general would include besides planning, coordination and monitoring also the O&M of the centralised treatment plants, but **not** the O&M of the sewer systems in the villages and towns. The responsibility for the treatment plants would have to include the force mains which run from the connected villages to the plants.

The reason to entrust O&M responsibilities for treatment plants to the FSD has to do with the size of the plants, their requirements for technical support, centralised purchasing and warehousing facilities, career development etc. The treatment plants serve a number of communities (urban and rural) rather than just one, and have a regional function, which calls for regional management.

Financing of O&M should be included in the Governorate's operational budget. Part of this budget may be covered from user fees. Another part must be subsidised from the Central Government (see section 8.3)

INSTITUTIONAL FRAMEWORK FAYOUM SANITATION DEPARTMENT

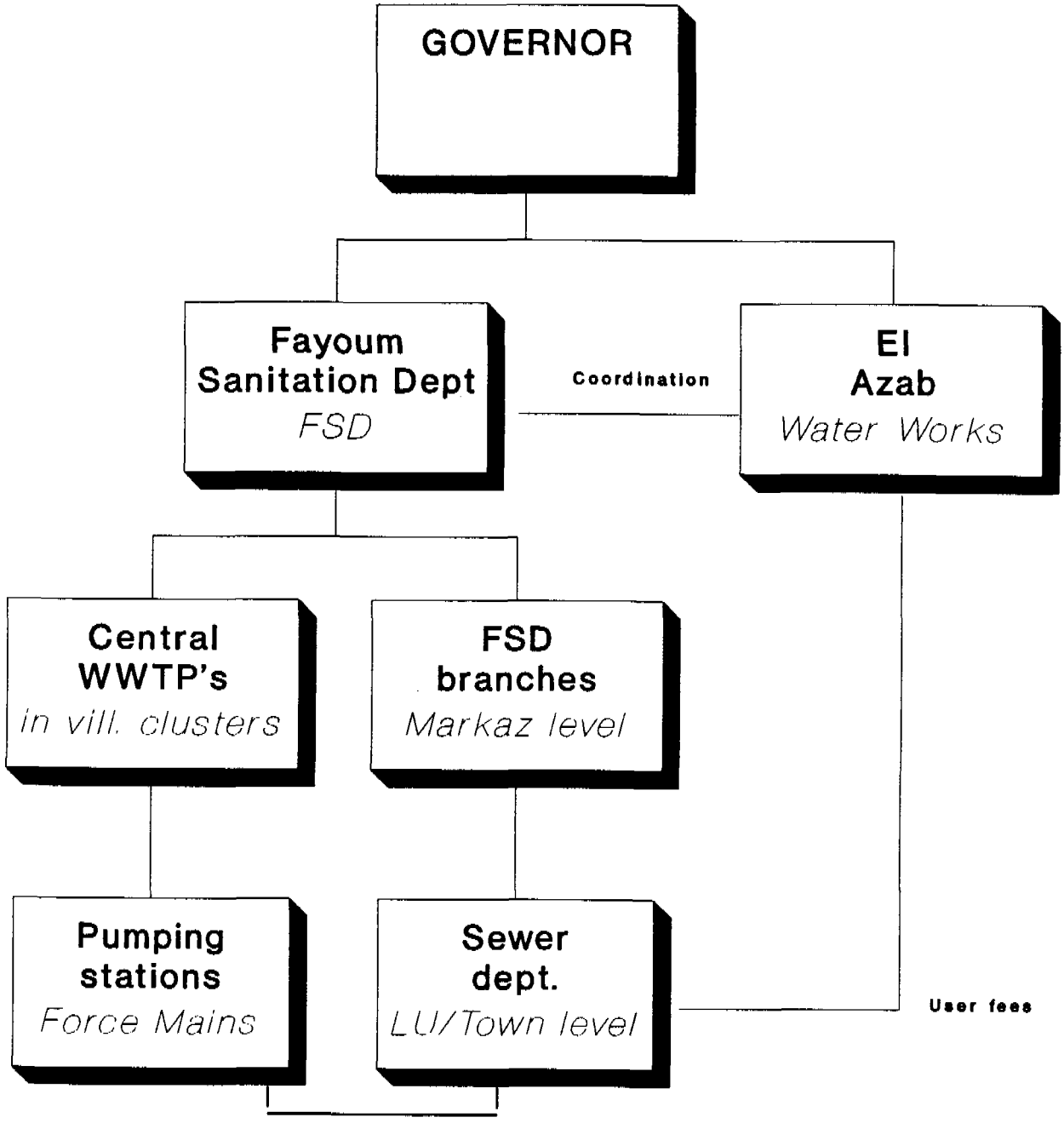


Figure 8.1

Table 8.1. Proposed division of responsibilities for wastewater

ADMINISTRATIVE LEVEL	HOUSE CONNECTIONS	SEWER SYSTEMS	PUMPS, MAINS & CENTRAL WWTP	ON-SITE SANITATION
NATIONAL LEVEL: NOPWASD		Approval of designs and providing full implementation budget	1. Planning/preparation, 2. Detail design and tendering 3. Financing 4. Construction supervision, 5. Training for O&M 5. O&M budget,	
GOVERNORATE: Fayoum Sanitation Department (FSD)		1. Planning/preparation, 2. Detailed design and tendering, 3. Construction supervision, 4. Training for O&M 5. O&M budget,	Daily O&M	
El Azab Water Utility	Fee collection		Laboratory services	
Ministry of Health (MOH)	Promotion		Monitor effluent quality	Promotion programme
Fayoum Irrigation Department (FID)		Approval for disposal of sewage in drain (in case of modular sewerage)	Approval for effluent disposal into drain	
MARKAZ: Wastewater Department		Specialist O&M services and technical assistance		
TOWN/LOCAL UNIT: Sewer Department	Planning, construction supervision and O&M	Daily O&M		
Vacuum Trucks		Disposal of sludge in sewer	Disposal of sludge at plant terminal	Desludging services
HOUSEHOLDS	Pay connection costs and monthly service fee			Planning, financing, implementation and O&M

Markaz level

In every Markaz a branch office of the FSD has to be established. Its main task is to provide technical services to the city and villages concerning the O&M of their sewer systems.

City and Local Unit level

Cities and Local Units are responsible for the day-to-day O&M of their collection system.

The sewage collection system is generally limited to the city or village area, so there can be a well-defined responsibility. The maintenance of the networks can to a large extent be carried out by unskilled labourers who may be recruited and trained on the job in the village itself.

The operations should be financed from the local administration who receive their budget from the Governorate.

El Azab Water Works

El Azab will have two main duties with respect to the wastewater operations: collection of user fees, and the provision of laboratory facilities.

Collection of user fees will be combined with the water bill, and processed at the company's billing department. The collected amounts will be transferred to the Governorate and may be used for the financing of treatment plant operations and O&M of sewer systems.

El Azab has a well equipped laboratory which can perform the required analyses for influent and effluent of wastewater treatment plants. On the short term there would be no need to construct and equip a new laboratory.

8.2.3 On-site sanitation

Decisions on having a latrine or a wastewater disposal facility are taken at household level. Costs, technical feasibility, convenience, status, access to piped water etc. are all aspects that play a role.

Institutionally, on-site sanitation may be supported in three ways:

a. Department of Health:

- promotional activities and hygiene education campaigns;

- development and design of alternative low-cost sanitation options;
- demonstration projects in villages.

b. Local Government at Markaz or town level:

- extension and improvement of desludging services;
- providing Local Units with vacuum trucks, and supporting maintenance of trucks at Markaz level.

c. Governorate level:

- provide funds for expanding the fleet of vacuum trucks and increase O&M budgets;
- stimulate development of alternative sludge disposal methods;
- formulate a Governorate wide latrine promotion and hygiene education programme.

It has been made sufficiently clear in this masterplan that the formulation of an on-site sanitation support programme for Fayoum is of utmost importance, especially for the low income groups.

8.3 COST RECOVERY

8.3.1 General

Cost recovery for sewerage and wastewater treatment must be considered in a different way as compared to cost recovery for drinking water supply. For drinking water it is justified to aim at full cost recovery from customer fees on the relatively short term, since the investments are aimed at rather clear benefits for the consumers.

This is also true for investments in sewer systems because of the direct benefit for the population, but for wastewater treatment the benefits reach beyond the population of the villages served with sewerage. Wastewater treatment satisfies a more general goal of environmental protection, but requires investments and operational costs for which it can be expected that the majority of the rural communities in Fayoum do not have the financial capacity to contribute. Therefore it can be expected that only partial cost recovery can be aimed at.

The first priority is to seek cost recovery for sewerage.

In the financial analysis presented below, a relationship is made with the proposed tariff development for drinking water (see chapter 6 of Water Supply Masterplan).

The analysis is based on the costs of sewers and treatment for the eight priority villages mentioned in section 6.3.1. Table 8.2 summarises the sewerage coverage for the year 2000 in these villages. Of the projected population of 203,000 some 100,000 people are expected to be served through 16,900 house connections.

Table 8.2. Priority villages for sewer systems (from table 6.2.a.)

Village	Population year 2000	Population served 50%	No. of house connections *)
Tutoon	32,145	16,100	2683
Minya El Heat	32,993	16,500	2750
Qalamshah	26,962	13,500	2250
El Roda	21,192	10,600	1767
Tersa	20,071	10,000	1667
Garado	23,532	11,800	1967
Toubhar	27,440	13,700	2283
Naqalifa	18,504	9,300	1550
TOTAL	202,839	101,400	16900

*) based on 6 persons per connection

8.3.2 Financial analysis

Table 8.3 summarises per capita and total investment costs, annual capital costs and per capita and annual O&M costs for the total population served in the eight priority villages. Investment and O&M costs are based on section 3.5 (table 3.1.) Capital costs are based on 6% interest.

The mentioned investments in treatment plants of LE 13.7 million do not represent the full costs of the plants but only the share of the eight villages in the central plants to which they are connected, based on an average per capita investment of LE 135. The same applies to capital and O&M costs of treatment.

Table 8.3 Summary of investment costs, capital costs and O&M costs for the eight priority villages (pop. served: 101,400)

Category	Unit	House connections	Sewers	Pumps and mains	Treatment plant	Total
Total investment 8 villages	Million LE	2.50	20.30	8.60	13.70	45.10
Investment costs	LE per cap.	25.00	200.00	84.80	135.00	444.80
O&M costs	LE per cap./year	-	2.25	2.90	5.00	10.15
Annual capital costs (annuity 6%)	Million LE	0.20	1.47	0.60	1.20	3.47
Annual O&M costs	Million LE	-	0.23	0.29	0.51	1.03

Annual O&M and capital costs for the various system components are shown graphically in figure 8.2. It is obvious that capital costs are especially dominant for the sewers (high investment/limited O&M costs), whereas for wastewater treatment the difference between capital costs and O&M costs is less pronounced.

Fig. 8.2 Annual O&M and capital costs of waste water system components

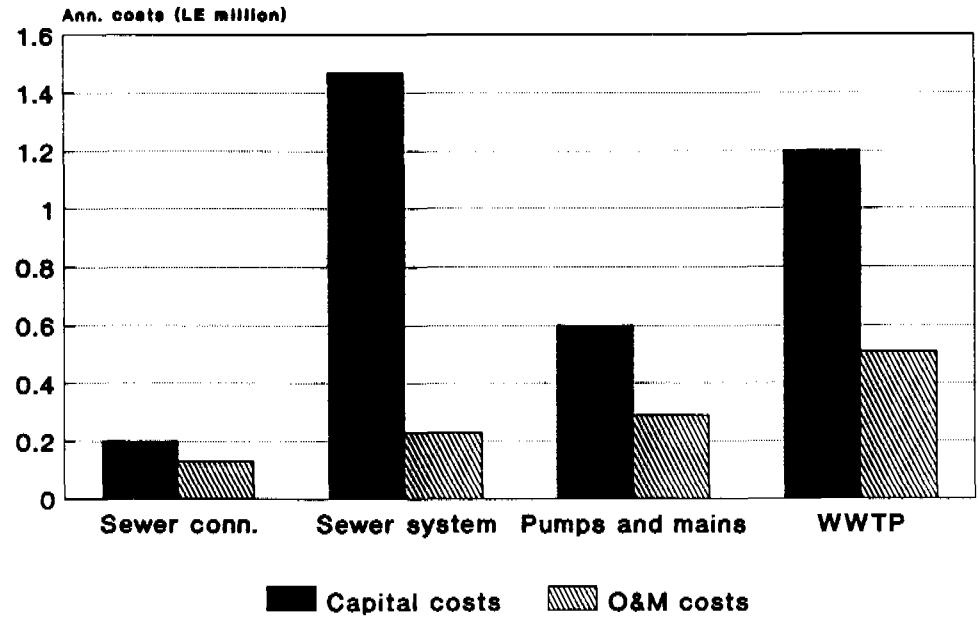


Table 8.4 shows five ascending degrees of cost recovery for sewerage and sewage treatment, and their annual costs based on table 8.3. For each option the annual costs are expressed as the percentage of the maximum possible water revenues from the 16,900 house connections. From table 6.6 (Water Supply Masterplan) it can be seen that the consumer classes B and C account for respectively 10.3 and 9.2 % of all consumers. A 50/50 division in the 16900 HC's is therefore considered, with a total maximum annual revenue of LE 1,825,200.

Table 8.4 Annual costs of sanitation (100,000 people served/16,900 HC's) as percentage of potential water revenues (year 2000) *)

Degree of cost recovery	Annual costs (LE)	As % of max. water revenues
1. O&M of sewerage	230,000	12.6 %
2. O&M of sewerage and treatment	1,030,000	56.4 %
3. O&M and 50% of sewerage cap.costs	1,770,000	96.9 %
4. O&M and 100% of sewerage cap.costs	2,500,000	137 %
5. Full cost recovery	4,300,000	235 %

*) assumption: 16,900 households with sewer- and water connection, equally divided over consumer classes B and C (see table 6.6, water supply masterplan), with average water bill of LE 9 per month. Maximum water revenues are thus 16,900 * LE9 * 12 = LE 1,285,200 per year.

Conclusion

It is thus shown that with the present 30% surcharge on the water bill for sewerage, the O&M costs of sewerage can be well recovered. If recovery of O&M costs of sewerage is to be included, the surcharge should be 56.4%. This is considered a realistic target for the year 2000, and it matches the cost recovery target for water supply. A gradual increase of the sewerage surcharge from the present 30% to 60% in the year 2000 is therefore recommended (see also table 6.9 in the Water Supply Masterplan). Recovery of capital costs (options 3 to 5, is not yet feasible).

Attempts to stimulate community participation in the financing of sewer systems, through upfront payments before the start of the implementation, or through revolving funds are not recommended, simply because these contributions are not affordable to the people. Sewer systems are to be fully externally financed. Beyond the year 2000, depreciation and capital costs may be included in cost recovery targets.

Instead, community participation efforts should be directed to promotion of improved in-house facilities whereby the target is that as much as possible households will have: a water connection, a safe latrine and a proper wastewater disposal facility.

8.3.3 Financing of required investments

Investment requirements were analysed in chapter 6. They amount to approximately LE 126 million in the period 1994-2000, as specified in table 8.5. In addition to investments in capital works, an estimated TA budget is required of some LE 18 million for engineering services and organisational support. Community contributions amount to an estimated LE 33.3 million (26% of total), mainly in on-site sanitation facilities and sewer connections.

The remainder is to be financed externally from loans and grants. It is recommended to finance TA requirements exclusively from grants. Furthermore it is recommended to finance the proposed sewer systems from grants and the treatment facilities from a loan.

The total loan amounts to LE 20 million, which could be disbursed at once. The investment grants amount to LE 72.6 million and could be disbursed in three installments.

It should be noted that it is not clear which financing arrangements have been made for the already committed projects. It is however quite certain that only funds for the treatment plants are available and not yet for the sewer systems.

Table 8.5. Annual investments, TA requirements and financing plan (1994-2000), in million LE

INVESTMENTS	1994	1995	1996	1997	1998	1999	2000	TOTAL community	TOTAL
Committed projects	11.3	10.2	4.8	7.3	8.2	5.4	4.4	3.1	54.7
New 1st priority	7.8	4.3	3.4	3.5	2.8	4.5	2.6	2.5	31.4
New modular sewerage	1.0	0.9	0.8	1.3	0.6	0.7		0.7	6.0
On-site sanitation	1.0	1.0	1.0					27.0	30.0
Desludging	1.0	1.0	1.0	0.8					3.8
TOTAL INVESTMENTS	22.1	17.4	11.0	12.9	11.6	10.6	7.0	33.3	125.9
TECHNICAL ASSISTANCE									
Detailed design and supervision	2.2	2.2	2.2	2.2	1.0	1.0			10.8
Start-up O&M			0.4	0.4	0.4	0.4	0.2		1.8
Organisational support	1.5	1.5	1.0	1.0	0.4				5.4
TOTAL TA	3.7	3.7	3.6	3.6	1.8	1.4	0.2		18.0
TOTAL FINANCING REQUIRED	25.8	21.1	14.6	16.5	13.4	12.0	7.2	33.3	143.9
PROPOSED FINANCING									
Investment Loan		20.0							20.0
TA Grant	3.7	3.7	3.6	3.6	1.8	1.4	0.2		18.0
Investment Grant	22.1		25.5		25.0				72.6
Community contribution									33.3

8.4 FIRST PHASE ORGANISATIONAL DEVELOPMENT PROGRAMME

Organisational development for wastewater services is required for sewerage and sewage treatment, and for on-site sanitation. Sections 8.4.1 and 8.4.2 deal with sewerage; section 8.4.3 with on-site sanitation.

A detailed programme is not elaborated but basically the steps are indicated. The detailed programmes should be prepared after basic agreements have been obtained on the scope and timing of the required organisational adjustments. This can be done in the framework of the proposed external support programme.

8.4.1 Phasing of targets

Organisation development for sewerage and wastewater treatment in Fayoum (excl. Fayoum City) has to start virtually from zero. It is therefore important to phase targets realistically.

The general objective is to have a well developed Sanitation Department in place by the year 2000, with responsibilities as outlined in table 8.1. This organisation will, during the period of its development, have a full Governmental status, but with clearly delegated responsibilities.

Until the year 2000, design, tendering and financing of especially the treatment plants will have to be arranged from the central level (NOPWASD). FSD however will indicate the requirements, based on the masterplan, and decide on capacity, location, phasing of construction etc. For sewerage projects FSD can be more independent, apart from the financing. FSD can prepare independently Terms of References for sewerage projects and tender these (through the Governorate), provided funding has been assured.

The organisation will have to ensure cost recovery for sewerage and sewage treatment, so cooperation with El Azab for billing purposes is required.

The following phasing of the organisational development process is proposed:

PHASE I: 1994-1996 ESTABLISHMENT OF THE FSD

The present FSD is still a rudimentary organisation, for which however a good organisation structure is available (see figure 2.3). A few years are required to actually establish this organisation.

PHASE II: 1996-2000 O&M AND COST RECOVERY

By the start of this phase it is expected that a few of the newly planned treatment plants will have become operational. FSD will be responsible for their O&M, and will have to oversee sewerage operations at town/village level. At the same time cost recovery for O&M has to be ensured.

PHASE III: 2000-2010 AUTONOMY AND INTEGRATION

FSD can become more autonomous and integration in the water company may be considered.

The following targets until the year 2000 are formulated:

Before 1994 basic agreement of the Governorate should be available on:

1. Agree on wastewater responsibilities (ref. table 8.1);
2. Agree on cost recovery principles;
3. Agree on the organisation structure of FSD and related job descriptions;

4. Allocating adequate office space to the FSD;
5. Agree on an external support programme for the FSD.

Phase I (1994-1996):

If the agreement on the above issues is obtained, the FSD should focus on the following:

1. Establishing the organisation of the FSD (staffing, establishing Markaz branch offices);
2. Cooperating with El Azab on billing and revenue collection;
3. Preparing training facilities for O&M staff of treatment plants and village/town sewer departments;
4. Supervision of ongoing implementation of treatment plants and sewers;
5. Initiation, fund raising and preparation of sewer systems in priority villages.

Phase II (1996-2000):

The activities of phase I should be continued. In addition the following is aimed at:

1. Managing O&M of constructed treatment plants;
2. Overseeing O&M of available sewer systems in towns/villages;
3. Cost recovery for O&M;
4. Deciding on integration in the Water Company.

8.4.2 Proposed activities

In table 8.6 the proposed activities of the FSD are listed for the second phase. It is recommended that during the development period of the FSD, the organisation is supported by an external Technical Assistance support programme.

Table 8.6. Activities of the FSD (1994-1996)

	ACTIVITIES OF FSD	TARGET
1.	Prepare FSD organisation structure and job descriptions	Agreement from Governorate
2.	Staff recruitment and office development	Performance of FSD
3.	Prepare designs and budget proposals for priority sewerage projects	Financing of sewerage systems
4.	Supervision of ongoing implementation of treatment plants and sewerage projects	Ensure quality of construction work
5.	Prepare or select training opportunities for sewerage O&M staff	O&M of sewerage
6.	Prepare or select training opportunities for treatment plant O&M staff	O&M of treatment plants
7.	Assume responsibility for O&M of constructed treatment plants	Trouble free operation of treatment plants
8.	Oversee O&M of sewerage systems in towns and villages	Functioning of sewer systems
9.	Develop cooperation with El Azab on billing and revenue collection	Cost recovery

8.4.3 Organisational development for on-site sanitation

Since on-site sanitation is basically the responsibility of individual households, the Government can only assume a stimulating and supporting role. There is a major task for the Ministry of Health in this regard, where it is concerned the promotion of safe and sanitary hygienic practices. As far as we are aware, there is at present no specific ongoing on-site sanitation promotion programme in Fayoum. It is strongly recommended that this be developed.

Secondly, it is clear form the preceding chapters that desludging services require substantial improvement. It is strongly recommended that Local Units operate their own desludging trucks, and that their O&M is at least partly subsidised by the Government.

Repair, servicing and maintenance facilities do not have to be available in every Local Unit but these may be concentrated in the markaz capitals.

CHAPTER 9

MAIN CONCLUSIONS, TIME SCHEDULE AND RECOMMENDATIONS

9.1 INTRODUCTION

In this chapter the main conclusions and recommendations from the previous chapters are summarised. An implementation schedule is provided for the period 1994-2000. In 1999 an update of the masterplan should be prepared on the basis of which a more detailed programme for the period 2000-2010 can be formulated.

The activities start in 1994 after the formal approval and adoption of the masterplan. In the subsequent three years 1994 through 1996 an external support programme is required, which shall concentrate on:

1. assisting with establishing the FSD, and training its key staff;
2. preparation of detailed designs for priority sewer systems;
3. arranging the required investment funds for the 1st priority sewerage projects;
4. preparing for cost recovery.

9.2 MAIN CONCLUSIONS AND RECOMMENDATIONS

9.2.1 Sewerage and sewage treatment

By the year 2020 all villages over 15,000 inhabitants should be sewered. This concerns about 90 localities with a total population to be served of about 1.6 million (60% of the total population).

Since it would be rather inefficient to have a separate wastewater treatment plant for every locality, twelve clusters of villages have been designed, with one central treatment plant in each cluster (see figure 5.3). The number of treatment plants in the area can thus be significantly reduced.

By the year 2020 most of the sewered villages would be connected to a regional treatment plant. The plants which have been planned already by NOPWASD for Fayoum, can, with some relocations cover the entire need for wastewater treatment capacity upto at least the year 2000. No new plants have to be considered on the short term.

In order to decide the localities which should be served first, a priority ranking has been executed taking into account such factors as: population size, water service level, regional importance, socio-economic development and environmental impact. The resulting priority list of localities is presented in table 4.7.

Five wastewater treatments are at present either completed or ongoing (Sanhur, El Nazla, Senoures, Ibshway and Sanhur), while seven other treatments have been committed by NOPWASD (tables 6.1.a, b and c). Eight other locations (table 6.2a) belong to the high priority projects to be completed before the year 2000, but only for sewerage, since they can be connected to a regional treatment plant. In addition there are six locations where modular sewerage is projected, with communal septic tanks and upflow anaerobic filters as a temporary local treatment.

With the above projects, around 250,000 people could be served by the year 2000 at a total investment of LE 95 million.

9.2.2 On-site sanitation

It was found in the surveys that some 50% of the rural population has no latrine nor a wastewater disposal facility. In hamlets this figure is even 60%. This condition prevails among the lower income groups, and mostly concerns households without piped water supply in the house.

House connections for water supply have a positive impact on access to sanitary facilities (78% access as compared to only 23% access of public tap users).

It is impossible to cover all the needs for wastewater disposal by sewerage. It is estimated that even by the year 2020, still 40% of the population will have to rely on on-site sanitation.

Four fields of action were identified:

1. providing 1.4 million people (some 175,000 households) with an on-site sanitation facility (upto the year 2020). In order to achieve this target the following strategy should be developed;
2. development and promotion of alternative low-cost on-site sanitation technical options;
3. considerable extension of desludging facilities and improvement of the provided services;
4. intensification of hygiene education programmes, particularly directed at low income groups.

Upto the year 2000, some 300,000 people (40,000 households) should be served at total investments of LE 30 million, for the larger part private household investments.

9.2.3 Operation and maintenance

There is limited experience with O&M of wastewater treatment plants or sewer systems in Fayoum (apart from Fayoum City). For treatment plants, O&M start-up services are required with adequate on-the-job training. After such a transition period O&M should be transferred to the FSD, who should employ a crew on each of their plants.

O&M of sewers is to be carried out at village/town level by a specialised department of the municipality. An O&M budget should be provided for each village, which can be covered from user fees.

9.2.4 Cost recovery

It has been analysed that recovery of O&M costs of sewerage can be realised by a 12.6% surcharge on the water bill. If O&M of treatment is to be included the surcharge should be 56.4%. It is recommended that the sanitation surcharge in the year 2000 should be 60% of the waterbill.

Investments in treatment plants and sewer systems should be entirely covered from external funds, except for the house connections. Recovery of capital costs is not feasible until the year 2000.

9.2.5 Organisational development

With the projected increase of sewerage and sewage treatment in rural Fayoum, a well established Sanitation Department is required in the Governorate, which can gradually take over responsibilities from NOPWASD. A committment from the Governorate is needed to provide the required facilities for the FSD. Only then will an external support programme be meaningful.

9.3 IMPLEMENTATION SCHEDULE

9.3.1 Activities

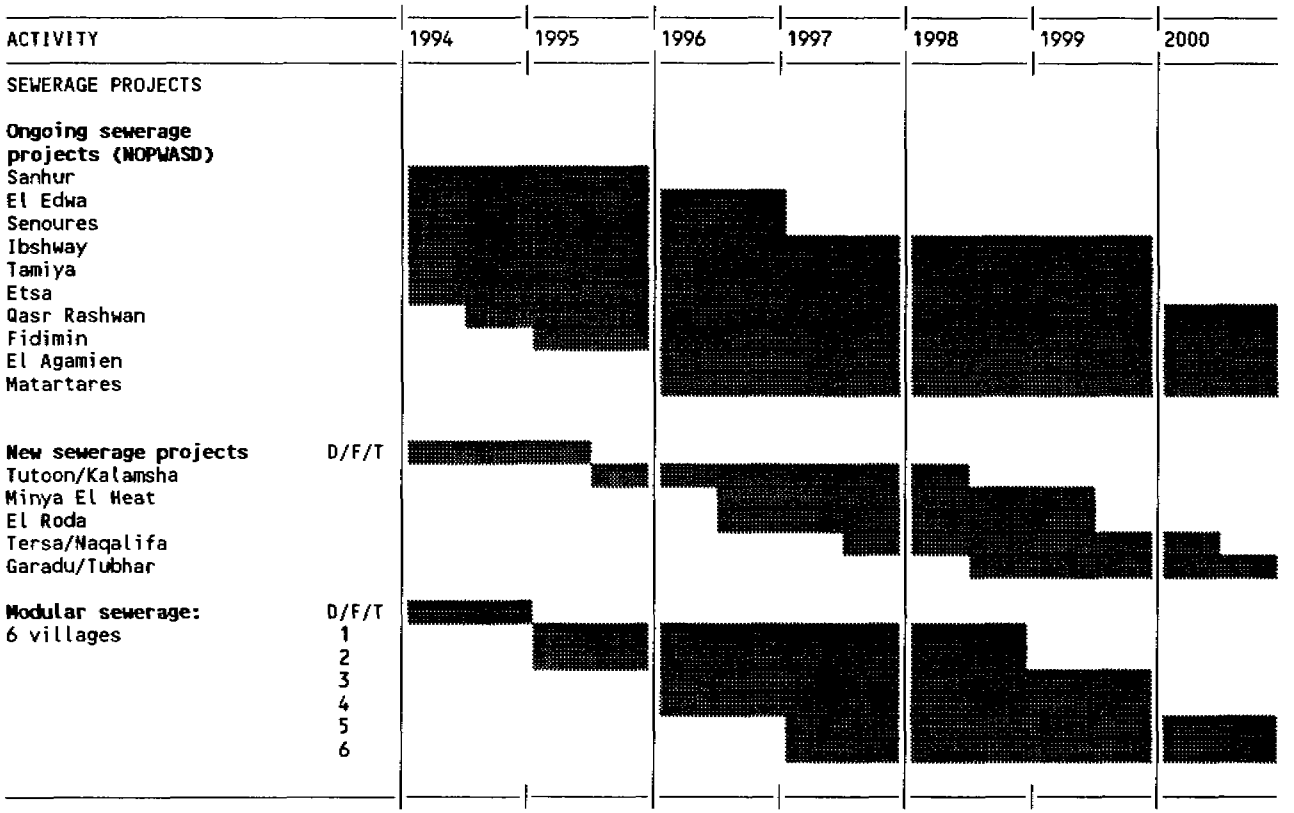
The activities for the period upto the year 2000 are shown in the time schedule of figure 9.1. The activities are grouped into: sewerage, on-site sanitation and organisational development. Critical activities are:

- the take-off of the FSD;
- the start of an on-site sanitation programme;
- funding of the implementation projects.

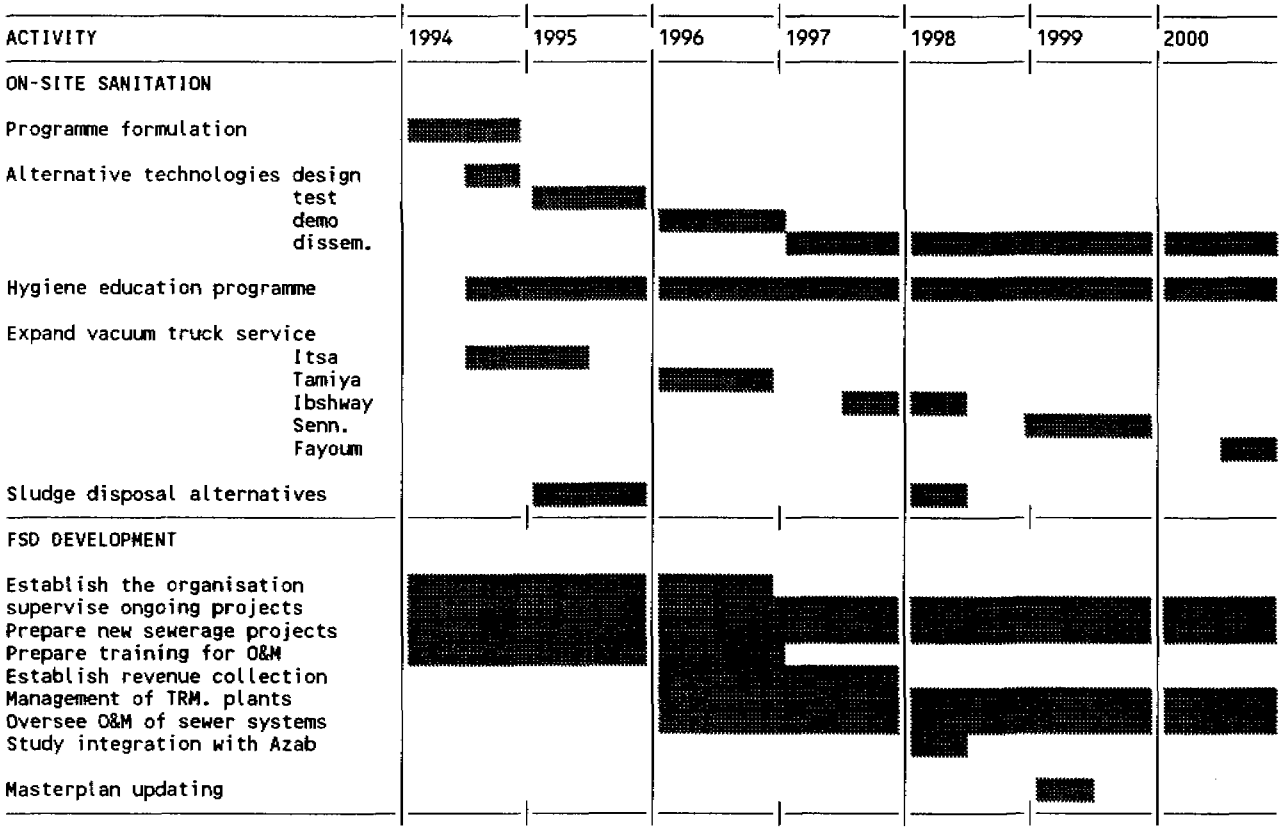
External consultants services have to be acquired for the preparation of feasibility studies, preliminary and detailed designs. Based on this output, funding proposals can be prepared, which can be assessed by Egyptian financing agencies and donors alike.

It is recommended that based on the masterplan, a few donors commit themselves to financing (parts of) the masterplan. This will limit the time required for fund raising. The exact amounts to be provided as loan, grant or local contribution, will be established after the completion of detailed designs.

FIGURE 9.1 TIME SCHEDULE WASTEWATER ACTIVITIES 1994 - 2000



Time schedule continued



9.3.2 Estimated manpower inputs, costs and financing

Total investment costs and TA requirements upto the year 2000 were summarised in table 8.5. Manpower requirements of FSD have not yet been assessed in detail, but this will be done as a follow-up activity to the masterplan, once the responsibilities have been agreed upon.

External cosnsultants services are especially intensive in the period 1994-1996. For the support programme two Egyptian - and one full time expatriate consultants are required. This is excluding consultancy services for the preparation of detailed designs.

It is recommended that the consultants services for the organisational support programme be covered from the ongoing Netherlands supported FaDWS project. Specific engineering consultants services for preparation of detailed designs and tender documents for the major investments may be contracted separately.

The detailed workplans for these services are not included here but shall be prepared separately in compliance with the masterplan.

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