In view of above mentioned comments, the following criteria are recommended:

All sanitary sewers shall be so designed and constructed to give minimum velocities when flowing full or half-full, of not less than 60 cm/sec for CP, or PVC, based on the Manning formula. For RCP or any cement-bonded pipe the minimum design flow velocity should be 75 cm/sec.

(b) Maximum Velocity

The maximum velocity should not exceed 3.0 m per second, to protect sewer erosion. Where the ground surface slope is steep and velocities of more than 3.0 m per second may result, special provision should be made to protect against displacement by erosion and shock.

4.4 Design Depth of Flow

The peak flows usually occur twice a day, morning and evening. The rest of the day, the sewage flow rate is less than the peak rate, therefore, if the sewer pipe is designed on the basis of 100 percent of the design peak flow, there will be some space above the water surface elevation in the pipe most of the day. Also, it is possible to carry wastes at a higher rate when flowing partly full than when flowing full. For example, in circular pipe the maximum flow may occur at 80 percent of the diameter, which is about 20 percent higher than for full or half-full flow rates. Also, full flow usually does not occur in pipes servicing a small number of homes.

Considering the above mentioned conditions, all circular pipes are recommended to be designed on the basis of 100 percent full capacity.

4.5 Slope

Sewer sections and slopes should be designed so that the velocity of flow will not be less than 60 cm per second for clay or PVC pipes and 75 cm/sec for concrete or cement-bonded pipes. Each pipe section will be separately evaluated to determine the minimum design velocity nenessary to control sulfides.

Table IX-3 shows the minimum slopes which should generally be provided, however slopes greater than these values are desirable.

Table IX-3 Minimum Slopes for Sanitary Sewers

Sewer Size (mm)	Minimum Slope (m/1,000m)		Velocity (m/sec)	
	Clay or PVC Pipe	Concrete or Cement Bonded Pipe	Clay or PVC Pipe	Concrete or Cement Bonded Pipe
200	3.5	5.5	0.618	0.774
250	2.6	4.5	0.618	0.813
300	2.2	4.0	0.642	0.865
350	1.8	3.5	0.643	0.897
400	1.6	3.0	0.663	0.908
450	1.4	2.6	0.671	0.914
500	1.3	2.4	0.693	0.942
600	1.1	1.9	0.720	0.947
800	0.8	1.4	0.744	0.984
1,000 and larger	0.7 or less	1.1 or less	0.808 and more	1.012 and more

Note: Manning formula using an 'n' value of 0.013

4.6 Alignments

Sewers should generally be laid with straight alignment between manholes. Laying curved sewers should be avoided, unless the available sewer cleaning equipment can handle curvilinear alignments. Curvilinear alignments are, however, acceptable for large trunks where physical access inside the sewers can be readily accomplished.

4.7 Connection Method

When a smaller sewer joins a larger one, the invert of the larger sewer should be at a sufficiently lower elevation to maintain the same energy gradient. There are four methods which may be used:

(a) To place the crown of both sewers at the same elevation.

(b) To place the water surface of both sewers at the same elevation.

(c) To place the center of both sewers or approximately 0.8 depth point of both sewers at the same elevation.

(d) To place the invert of both sewers at the same elevation.

Selection of the most desirable method is a matter of economic judgement. In many cities where the flat ground slope does not allow deeper sewers, the problem has been solved by balancing the hydraulic disadvantages with the advantages gained from the reduced construction and maintenance costs of the system by using method (d) above. Because Sharqiya is quite flat, there may be significant differences in costs between sewers designed with different connection methods.

A study to select the best method for a sewerage system indicated that in case of invert type of connection, case (d) above, was the lowest and the center joint, case (c) above, was the second lowest. This is mainly due to difference of sewer depth. However, the differences in costs are small and do not appear to be significant.

The study also shows that the difference in construction cost for different types of sewer connections will not be significant in the areas of common topographic conditions. It is therefore recommended to use the crown type of connection, which has hydraulic advantages, with only small extra costs.

4.8 Joints

Infiltration is a major cause of hydraulic overloading of both collection system and treatment plant. Most system infiltration occurs through faulty or poor sewer joints. Private house connections to sewer mains have in many cases contributed more infiltration than the system itself.

Experiences in many countries show that the compression-type and rubber gasket joints have generally very superior performance in preventing groundwater infiltration into sewers. Various propriety forms of flexible joints are available on the market. Among them, the most reliable joint which has water tightness, flexibility, and durability is probably the rubber gasket type joint.

In view of the above mentioned comments, the following joints are recommended for different materials of sewer pipe;

(a) Concrete Pipe

Recently, concrete pipe manufacturers have successfully employed compression rubber gaskets for bell and spigot, and tongue and groove concrete pipes. A variety of these types of joints are available. It is therefore recommended that all concrete pipe joint be of the rubber-gasket type.

(b) Clay Pipe

Clay pipe can be obtained with factory-applied 'push-fit' joints. These can incorporate polyester rings and a rubber 'O' ring, or they may be of polyurethane with an integral nob. Any of these modern type joints which prevent infiltration would be acceptable.

4.9 Manholes

(a) Location

Manholes shall be installed at the end of each line; at all changes in grade, size, or alignment; and at all inter-sections. On larger trunk sewers, however, which can be entered for cleaning, these changes may be made without the requirement of manholes.

(b) Spacing

Spacings of manholes by size of sewer should not be more than as shown in Table IX-4. Manholes should, in any case, not normally be more than 200 meters apart, so that men working in a sewer can easily reach a manhole in an emergency.

Table IX-4 Maximum Manhole Spacings

Pipe Diam (mm)	300 or Less	600 or Less	1,000 or Less	1,500 or Less	1,650 or More
Maximum Spcaing (m)	50	80	100	150	200

(c) Dimensions

Except for very shallow drains and sewers of less than 1 meter depth to the invert (special case) all manholes should be of adequate dimensions for entry and for operation of cleaning rods. The internal size of manhole should not be less than 120 cm; but larger sizes are preferable. The recommended standard classification of manhole diameters and internal sizes are as follows:

Table IX-5 Recommended Shapes, and Manhole Diameter and Internal Sizes

(mm)

Type of Manhole	Shape	Size	Connecting Sewer Diameter
1	Circular	1,200	200 to 600
2	Circular	1,200	900 or less
3	Circular	1,500	1,200 or less
4	Circular	1,800	1,500 or less

(d) Materials

Generally manholes should be circular, with a reinforced base and brick mortar wall construction. Special care should be taken in wall construction in places where high groundwater is expected. In such cases where brick is to be used, the thickness should be more than one brick with a high quality mortar and skilled laborers. Where groundwater elevation is high, mortar coating on exterior of manholes should be considered so that groundwater infiltration will be prevented. The size of manhole covers either of reinforced concrete or cast iron should be greater than 60 cm.

For larger and deeper manholes, it is recommended that a precast concrete base, tapered sections, shaft sections and cover slabs be used in order to sustain heavy loads.

APPENDIX - X

SEWAGE TREATMENT PROCESS SELECTION

APPENDIX - X

SEWAGE TREATMENT PROCESS SELECTION

Table of Contents

List of Tables

List of Figures

1. Alternative Treatment Processes

Article 66 of the Executive Regulation for Law No. 48/82 stipulates the water quality standards for treated sewage when discharged to drains. In terms of BOD (Biochemical Oxygen Demand) and SS (Suspended Solids), maximum limits are set at 60 mg/l and 50 mg/l respectively. To meet these requirements constantly, design treatment goal should be set at a higher level, for example 30/30 or 40/40. Among the various secondary treatment processes available at present the following five processes are selected for consideration because of their treatment efficiencies. All of them are biological treatment processes and their technologies have long been established.

- Conventional activated sludge
- Extended aeration
- Oxidation ditch
- Aerated lagoon
- Oxidation pond

The conventional activated sludge process comprises of a grit chamber, primary sedimentation tank, aeration tank, final sedimentation tank, chlorine contact tank, sludge thickner, and sludge drying bed. The conventional activated sludge process is an aerobic, biological process which uses the metabolic reactions of microorganisms to attain an acceptable effluent quality by removing substances exerting an oxygen demand. Oxygen is supplied at an uniform rate throughout the aeration tank. This treatment method is usually considered to be a secondary treatment process, and follows a primary sedimentation tank. The expected BOD removal efficiency is 90 percent or higher when the system is properly operated. The flowsheet of the conventional activated sludge process is shown in Figure X-1.

The extended aeration process operates in the endogenous respiration phase of the bacterial growth cycle, which occurs when the BOD loading is so low that organisms are starved and undergo partial auto-oxidation. Because of the oxidation of more volatile solids during the long sludge retention time the waste sludge production is relatively low.

The hydraulic retention time in the aeration tank is about 33 hours. As shown in Figure X-2, this process consists of grit chamber, aeration tank, final sedimentation tank, chlorine contact tank, sludge thickner, and sludge drying bed, but primary sedimentation tank is omitted in comparison with the conventional activated sludge process. BOD removal efficiency is expected to be 90 percent or higher if the system is properly operated.

The oxidation ditch is a modification of the conventional activated sludge process and other facilities than aeration tank are same as those for the extended aeration process. Its essential operational features are that it receives screened or comminuted raw sewage and provides long retention times: the hydraulic retention time is commonly 1.0-2.0 days and that for the solids 20-30 days. The oxidation ditch is a long continuous channel, usually oval in plan and 1.0-3.0 m deep. The ditch liquor is aerated by one or more aerators placed across the channel. The aerators also impart a velocity of 0.3-0.4 m/sec to the ditch contents, sufficient to maintain the active solids in suspension and to circulation of the sewage. BOD removal efficiency is 90 percent or higher when the system is properly operated. Because of long retention time, nitrification and denitrification occur in aerobic and anaerobic zones in the ditch. This will require particular consideration for the design of the process. The flowsheet of the process is illustrated in Figure X-3.

Aerated lagoon is an activated sludge unit operated without sludge return. It is now usually designed as completely mixed non-return activated sludge unit. Floating aerators are most commonly used to supply the necessary oxygen and mixing power. When designed and operated properly, this process will achieve a high degree of removal and a better effluent than other processes can be expected in terms of bacterial removal. BOD removal efficiency is 90 percent or higher when the system is properly operated. The flowsheet of the process is illustrated in Figure X-4.

Oxidation ponds are large, shallow ponds in which organic wastes are decomposed by micro-organisms in a combination of natural processes involving both bacteria and algae. Oxidation ponds are one of the most economical method of sewage treatment wherever land is available at relatively low cost.

Their principal advantages are that they remove excreted pathogens at a much lower cost than any other form of treatment and that they have minimum operating and maintenance requirements. As shown in Figure X-5, this process consists of a series of anaerobic and facultative ponds with necessary auxiliary facilities to remove the BOD to the level of 90 percent or higher.

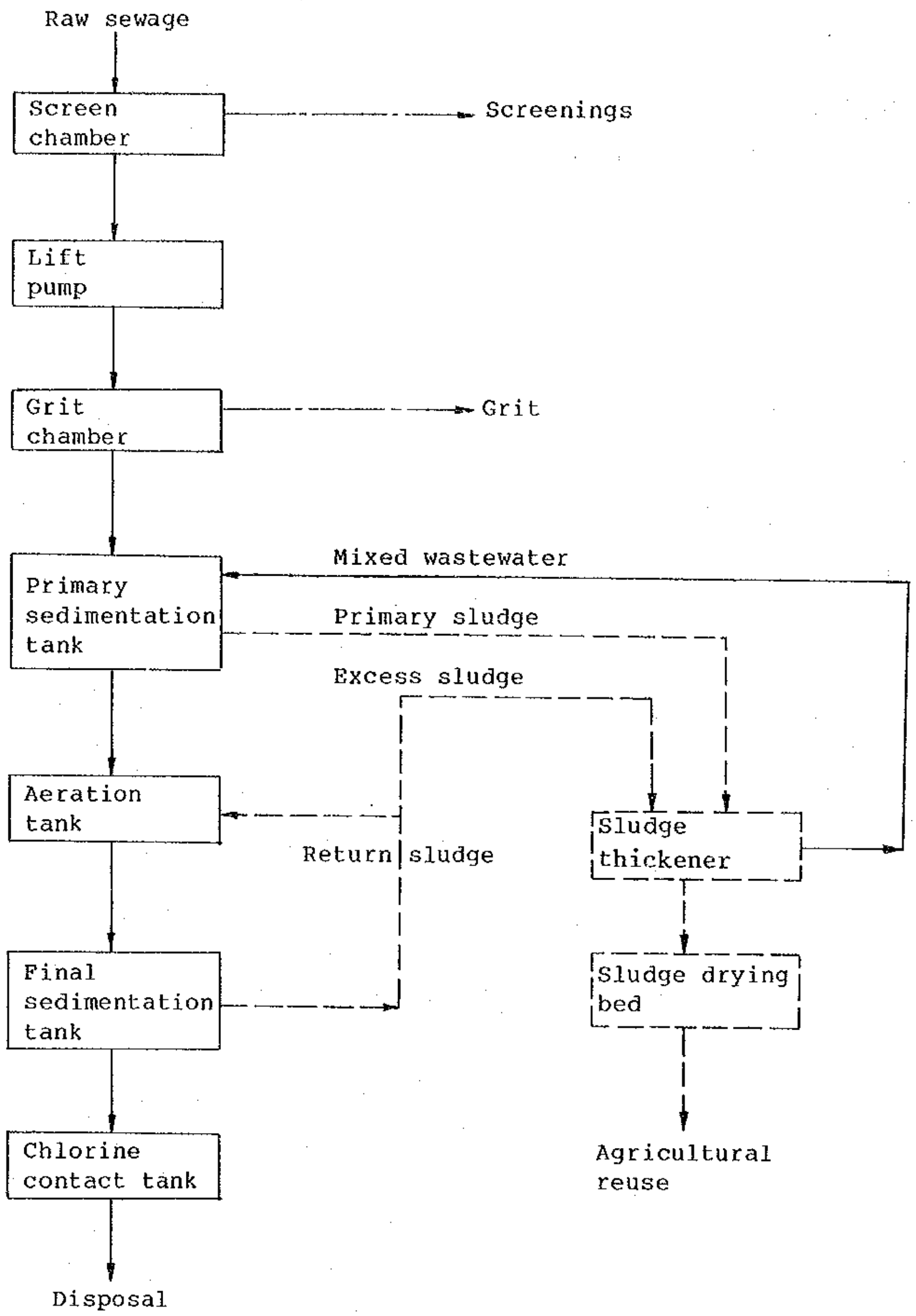


Figure X-1 Flowsheet of Conventional Activated Sludge Process

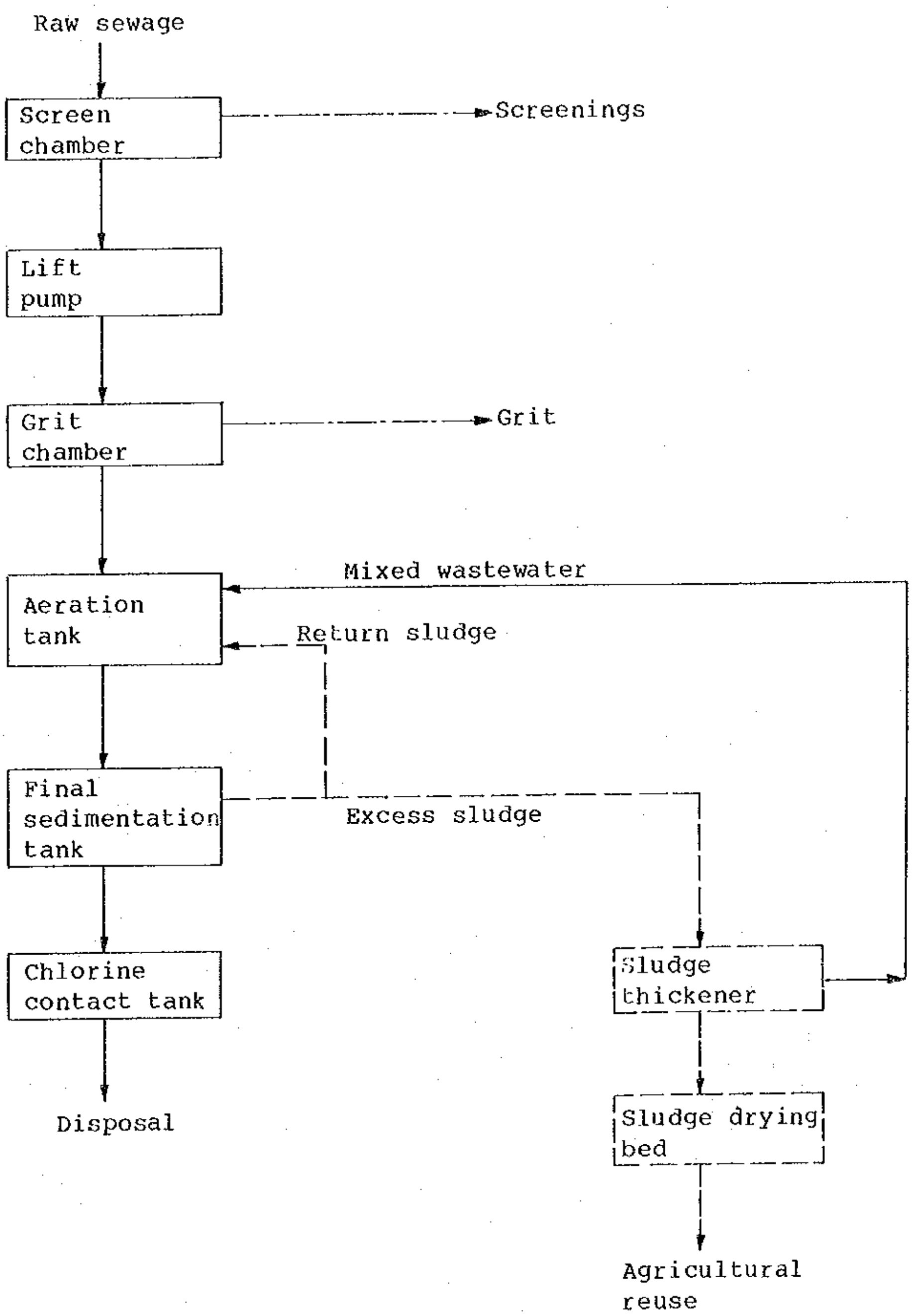


Figure X-2 Flowsheet of Extended Aeration Process

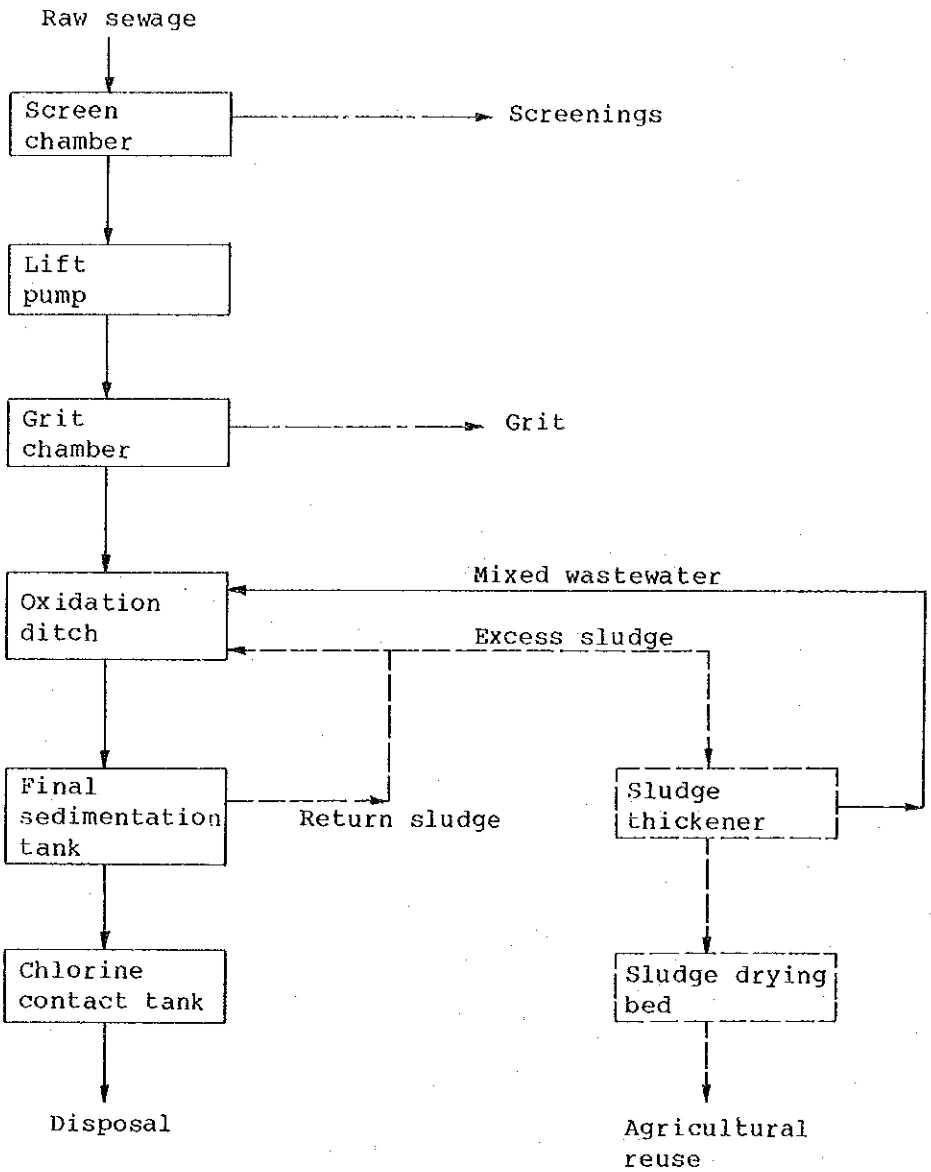


Figure X-3 Flowsheet of Oxidation Ditch Process

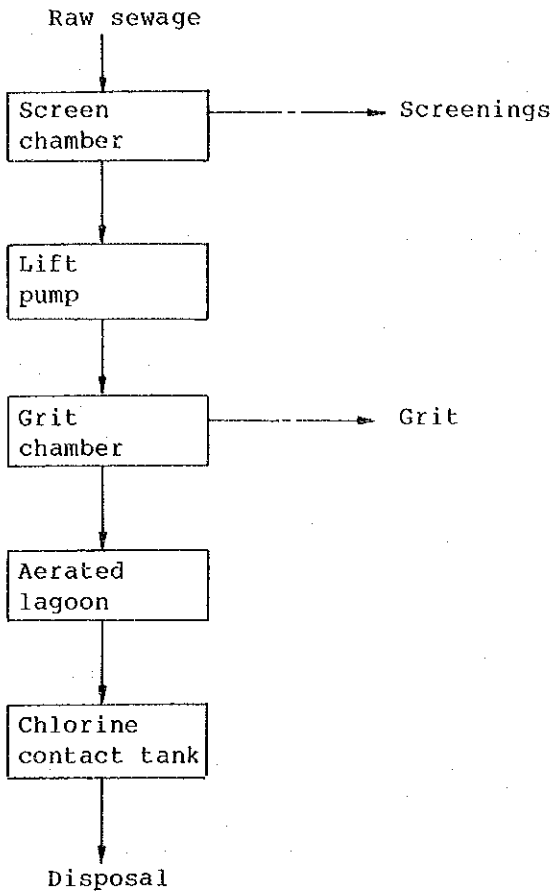


Figure X-4 Flowsheet of Aerated Lagoon Process

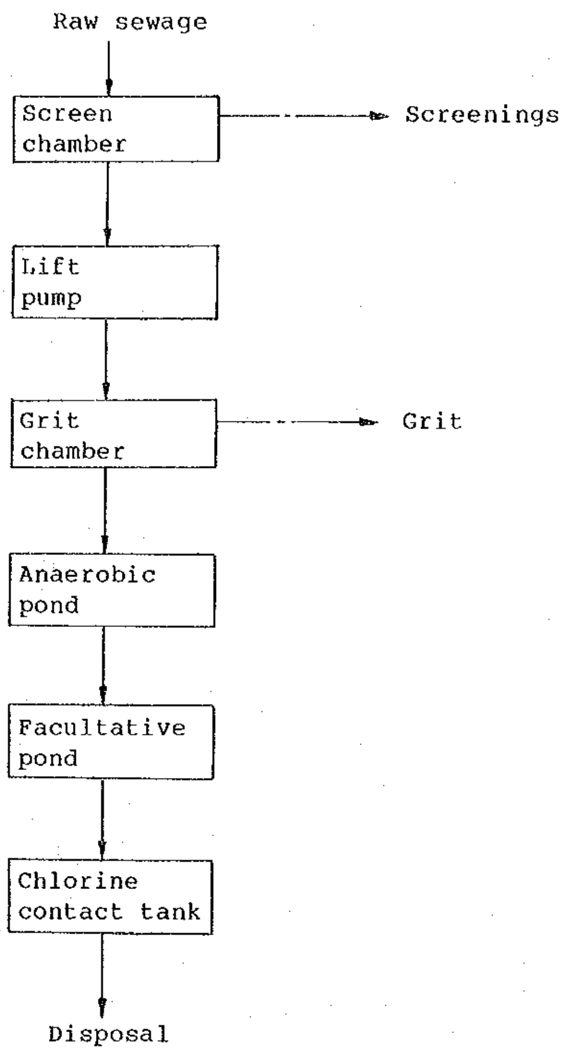


Figure X-5 Flowsheet of Oxidation Pond Process

2. Design of Plants

Taking into account the design flows of the 13 cities in the Governorate in 2005, flows of 10,000 m^3/day, 20,000 m^3/day and 40,000 m^3/day are selected for cost comparison. Design of the treatment plants for a total of 15 cases, i.e., 5 treatment processes and 3 design flows, are conducted to estimate the construction cost. Water qualities of the influent and effluent are determined based on method for the actual treatment works in the study. Water qualities in terms of BOD and SS are shown below.

	Influent	Effluent
BOD (mg/l)	450	30
SS (mg/l)	460	30

Design parameters of the unit processes which compose the aforesaid five processes are selected carefully to meet the above effluent quality requirements sufficiently. Main elements of the facilities, such as dimensions of the tanks and type of the pumps, aerator and mechanical equipment are shown in Table X-1.

3. Construction Costs

Construction costs of the treatment plants are estimated based on the design of each process described in the previous section and the unit cost of the each work item (see Appendix VII). Foreign currency portion of the construction costs, mostly related to supply and erection of mechanical and electrical equipment are estimated based on the quotation from the Japanese manufacturers converted to Egyptian Pounds at the official rate in mid-1987.

Construction costs are divided into four work items, namely civil, architectural, mechanical and electrical, for the estimation. Results of the cost estimation are tabulated in Table X-2 through X-6.

As shown in the tables, oxidation ditch process is highest in construction cost throughout the range from 10,000 m^3/day to 40,000 m^3/day, followed by extended aeration process and then activated sludge process. However, difference narrows as flow decreases. Aerated lagoon and oxidation pond processes are comparatively low in construction cost to the preceding three processes.

Table X-1 Design Outline of Alternative Processes

	Design Flow (Dairy Max.)	Screen Chamber	Lift Pump	Primary Sedimentation Tank	Aeration Tank	Final Sedimentation Tank	Chlorine Contact Tank	Sludge Thickener	Sludge Drying Bed
1. Activated Sludge Process									
Case 1	10,000 m3/day	W0.6xD0.6	Dia. 250 mm kw Nos.3	Circular, Mechanical sludge scraper Dia. 14.0xD3.0xNos.2	Mechanical aerator W12.0xL12.0xD4.0x Nos.8	Circular, Mechanical sludge scraper Dia. 16.0xD3.0xNos.2	W3.0xL12.0x D3.0xNos.1	Dia. 7.0xD4.0x Nos.2	W10.0xL11.0x D0.5xNos.10
Case 2	20,000 m3/day	W0.9xD0.9	Dia. 350 mm Nos.3	Circular, Mechanical sludge scraper Dia. 20.0xD3.0xNos.2	Mechanical aerator W17.0xL17.0xD4.0x Nos.8	Circular, Mechanical sludge scraper Dia. 22.0xD3.0xNos.2	W3.0xL24.0x D3.0xNos.1	Dia. 10.0xD4.0x Nos.2	W10.0xL11.0x D0.5xNos.20
Case 3	40,000 m3/day	W1.2xD1.2	Dia. 350 mm Nos.5	Circular, Mechanical sludge scraper Dia. 20.0xD3.0xNos.4	Mechanical aerator W17.0xL17.0xD4.0x Nos.16	Circular, Mechanical sludge scraper Dia. 22.0xD3.0xNos.4	W3.0xL48.0x D3.0xNos.1	Dia. 10.0xD4.0x Nos.4	W10.0xL11.0x D0.5xNos.40
2. Oxidation Ditch Process									
Case 1	10,000 m3/day	See Case 1 of A.S.P.	See Case 1 of A.S.P.	-	Oval Horizontal aerator W5.0xL100.0xD3.0x 2 channelsxNos.6	See Case 1 of A.S.P.	See Case 1 of A.S.P.	Dia. 6.0xD4.0x Nos.2	W9.0xL9.0x D0.5xNos.10
Case 2	20,000 m3/day	See Case 2 of A.S.P.	See Case 2 of A.S.P.	-	Oval Horizontal aerator W5.0xL150.0xD3.0x 2 channelsxNos.8	See Case 2 of A.S.P.	See Case 2 of A.S.P.	Dia. 8.0xD4.0x Nos.2	W9.0xL9.0x D0.5xNos.20
Case 3	40,000 m3/day	See Case 3 of A.S.P.	See Case 3 of A.S.P.	-	Oval Horizontal aerator W5.0xL150.0xD3.0x 2 channelsxNos.16	See Case 3 of A.S.P.	See Case 3 of A.S.P.	Dia. 8.0xD4.0x Nos.4	W9.0xL9.0x D0.5xNos.40
3. Extended Aeration Process									
Case 1	10,000 m3/day	See Case 1 of A.S.P.	See Case 1 of A.S.P.	-	Mechanical aerator W12.0xL12.0xD4.0x Nos.24	See Case 1 of A.S.P.	See Case 1 of A.S.P.	See Case 1 of O.D.P.	See Case 1 O.D.P.
Case 2	20,000 m3/day	See Case 2 of A.S.P.	See Case 2 of A.S.P.	-	Mechanical aerator W17.0xL17.0xD4.0x Nos.24	See Case 2 of A.S.P.	See Case 2 of A.S.P.	See Case 2 of O.D.P.	See Case 2 O.D.P.
Case 3	40,000 m3/day	See Case 3 of A.S.P.	See Case 3 of A.S.P.	-	Mechanical aerator W17.0xL17.0xD4.0x Nos.48	See Case 3 of A.S.P.	See Case 3 of A.S.P.	See Case 3 of O.D.P.	See Case 3 of O.D.P.

Table X-1 Design Outline of Alternative Processes (Cont'd)

	Design Flow (Dairy Max.)	Screen Chamber	Lift Pump	Aerated Lagoon Oxidation Pond	Chlorine Contact Tank
4. Aerated Lagoon Process					
Case 1	10,000 m3/day	See Case 1 of A.S.P.	See Case 1 of A.S.P.	Mechanical aerator W70.0xL210.0xD3.0 Maturation Pond W125.0xL125.0xD1.5 xNos.2	See Case 1 of A.S.P.
Case 2	20,000 m3/day	See Case 2 of A.S.P.	See Case 2 of A.S.P.	Mechanical aerator W70.0xL210.0xD3.0x Nos.2 Maturation Pond W125.0xL125.0xD1.5 xNos.4	See Case 2 of A.S.P.
Case 3	40,000 m3/day	See Case 3 of A.S.P.	See Case 3 of A.S.P.	Mechanical aerator W70.0xL210.0xD3.0x Nos.4 Maturation Pond W125.0xL125.0xD1.5 xNos.8	See Case 3 of A.S.P.
5. Oxidation Pond Process					
Case 1	10,000 m3/day	See Case 1 of A.S.P.	See Case 1 of A.S.P.	W150.0xL150.0xD1.5x xNos.4	See Case 1 of A.S.P.
Case 2	20,000 m3/day	See Case 2 of A.S.P.	See Case 2 of A.S.P.	W150.0xL150.0xD1.5x xNos.8	See Case 2 of A.S.P.
Case 3	40,000 m3/day	See Case 3 of A.S.P.	See Case 3 of A.S.P.	W150.0xL150.0xD1.5x xNos.16	See Case 3 of A.S.P.

Cost functions derived from the cost estimation by least square method are shown in Figure X-6 and described below.

Cost functions by treatment process

- Activated sludge process $C = 4.07Q^{0.799}$
- Extended aeration process $C = 5.54Q^{0.790}$
- Oxidation dictch process $C = 4.74Q^{0.788}$
- Aerated lagoon process $C = 1.84Q^{0.829}$
- Oxidation pond process $C = 1.58Q^{0.855}$

where C: construction cost(LE 1,000)

Q: wastewater flow (m^3/day)

Table X-2 Treatment Plant Construction Cost (1. Activated Sludge Process)

(LE 1,000)

Work Item	Case 1 (10,000 m3/day)	Case-2 (20,000 m3/day)	Case-3 (40,000 m3/day)
Civil	2,035	3,467	6,809
Architectural	623	770	1,105
Mechanical (Supply)	1,621	2,693	5,058
Electrical (Supply)	1,193	1,954	3,646
Transportation/Erection of Mech./Elec.	1,104	1,747	3,298
Total	6,576	10,631	19,916

Table X-3 Treatment Plant Construction Cost (2. Extended Aeration Process)

(LE 1,000)

Work Item	Case 1 (10,000 m3/day)	Case-2 (20,000 m3/day)	Case-3 (40,000 m3/day)
Civil	4,044	6,764	13,405
Architectural	557	680	912
Mechanical (Supply)	1,498	2,299	4,370
Electrical (Supply)	1,120	1,679	3,176
Transportation/Erection of Mech./Elec.	1,058	1,538	2,881
Total	8,277	12,960	24,744

Table X-4 Treatment Plant Construction Cost (3. Oxidation Ditch Process)

(LE 1,000)

Work Item	Case 1 (10,000 m3/day)	Case-2 (20,000 m3/day)	Case-3 (40,000 m3/day)
Civil	1,889	3,444	6,779
Architectural	557	680	912
Mechanical (Supply)	1,810	2,791	5,354
Electrical (Supply)	1,370	2,073	3,963
Transportation/Erection of Mech./Elec.	1,325	1,959	3,723
Total	6,951	10,946	20,731

Table X-5 Treatment Plant Construction Cost (4. Aerated Lagoon Process)

(LE 1,000)

Work Item	Case 1 (10,000 m3/day)	Case-2 (20,000 m3/day)	Case-3 (40,000 m3/day)
Civil	2,024	3,898	7,673
Architectural	410	436	620
Mechanical (Supply)	534	840	1,452
Electrical (Supply)	427	672	1,161
Transportation/Erection of Mech./Elec.	457	718	1,241
Total	3,852	6,563	12,147

Table X-6 Treatment Plant Construction Cost (5. Oxidation Pond Process)

(LE 1,000)

Work Item	Case 1 (10,000 m3/day)	Case-2 (20,000 m3/day)	Case-3 (40,000 m3/day)
Civil	2,941	5,733	11,342
Architectural	354	382	581
Mechanical (Supply)	350	471	714
Electrical (Supply)	280	377	571
Transportation/Erection of Mech./Elec.	299	402	610
Total	4,223	7,365	13,819

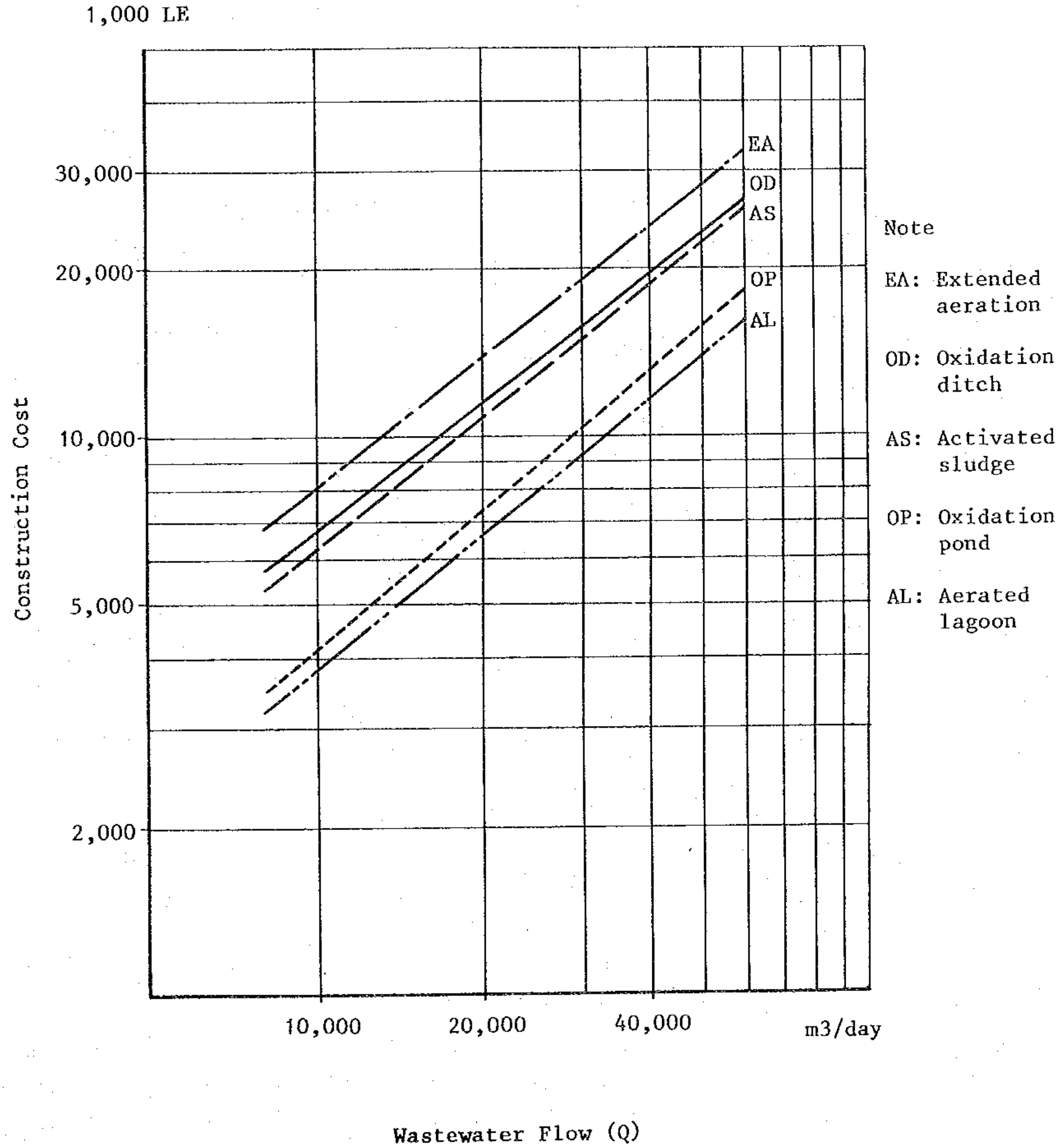


Figure X-6 Construction Cost Functions

4. Land Requirements

Necessary land spaces for each of 15 cases are figured out based on the layout plans of the treatment plants, which are shown in Table X-7. Spaces for the separation of the treatment plant from the surroundings, and for ancillary works such as work shop, yard piping, and connecting channels are taken into account.

Extended aeration process requires the minimum land spaces among the five treatment processes. Activated sludge and oxidation ditch processes closely follows the extended aeration process. Aerated lagoon and oxidation pond systems need much larger spaces than those of other processes and this tendency becomes more significant as wastewater flow becomes larger. This is mainly due to a fact that biological treatment units of these two process are composed of large and shallow ponds. This implies the disadvantage of the processes for large quantity of wastewater.

Table X-7 Necessary Land Spaces for Treatment Plant

(ha)

Process	Case 1 (10,000 m3/day)	Case-2 (20,000 m3/day)	Case-3 (40,000 m3/day)
Activated Sludge	2.1	2.9	5.3
Extended Aeration	2.2	3.0	5.3
Oxidation Pond	2.7	5.2	9.5
Aerated Lagoon	8.5	15.5	30.0
Oxidation Pond	13.3	25.6	48.9

5. Recommended Process for the Governorate

For the selection of the most appropriate treatment process, various factors related to engineering, environmental and economic aspects should be considered. These should reflect the specific conditions of the Governorate. Major factors considered for the selection are as follows.

- Construction cost
- Operation and maintenance cost and easiness
- Required land space
- Environmental impacts during construction and operation

Construction and operation and maintenance costs are one of the major factors for the selection. Construction cost are estimated and compared for the five processes in the previous section. Operation and maintenance cost shows similar trends as construction costs. Oxidation pond process requires the minimum cost because of the minimum power and chemical requirements. Aerated lagoon follows the oxidation pond system for the same reason. The other three processes are relatively costly and more or less at the same magnitude.

Easiness of the operation is another important factors to be considered, since most of the local municipalities which will be responsible for the operation of the treatment plant are rather small organization and shortage of the skilled technicians or operators are envisaged. With regard to this point, it should be noted for the new treatment plant presently under construction in Zagazig adopted activated sludge process. The experience obtained through the operation of the plant can be spread to the other cities under the supervision of the Governorate and Zagazig City. Oxidation pond system is considered as the easiest process in operation and maintenance, followed by aerated lagoon and oxidation ditch processes. Activated sludge and extended aeration process require more complicated procedures because of the nature of treatment process.

Land requirement is also an important factor for the selection, since the Governorate is situated within the Nile Delta and all of the 12 treatment plants will be located in the middle of the fertile agricultural land. Conservation of the agricultural land is a national policy in Egypt. Therefore, two processes, oxidation pond and aerated lagoon processes, which require a huge area are filtered out in this respect.

As mentioned in the first section of the Appendix, five alternative processes are selected because of their suitability to meet legal requirements for effluent quality. Therefore, there is no difference among the alternatives regarding water pollution control of the drains. Also, there is no difference about other environmental impacts envisaged during construction and operation. Construction and operation of each process are more or less similar nature, and there is no serious nuisance related to them.

Among the three alternative treatment processes, activated sludge for larger five cities and oxidation pond processes for the rest are recommended for the treatment systems in the Governorate for the reasons mentioned below.

- Activated sludge process has been adopted for the new Zagazig treatment plant. Techniques for construction and operation can readily be available to the other cities, particularly to the other four medium size cities which are expected to commence the project in the near future.

- For the large five treatment plants, construction cost and necessary land space are a most important factors because of the wastewater quantities. Activated sludge process is one of the least cost processes and smallest in space requirement.

- For the other seven treatment plants, oxidation process is recommended because of the ease of operation and maintenance, since manpower requirements will be a heavy burden for the small cities. Construction cost and land requirement for the process do not differ much from those for extended aeration and activated sludge processes.

APPENDIX - XI

WASTEWATER FLOW IN 2020 AND 2040

APPENDIX - XI

WASTEWATER FLOW IN 2020 AND 2040

Table of Contents

List of Tables

1. Introduction

As defined under the Scope of Work for the study, the main sewer capacities shall be determined based on the conditions in 2040. Also, the study team was informed by NOPWASD that the organization adopted wastewater flow in 2020 for the design of the sewerage facilities all over Egypt. Therefore, wastewater flows in the years of 2020 and 2040 are estimated in this Appendix although the target year of the study is 2005.

2. Estimates of Wastewater Production

2.1 Per Capita Wastewater Production

In the water supply feasibility study, the forecast of the future water consumption was made up to the year 2005, but no projections beyond that year. An assumption was made, for projecting per capita water consumption after 2005 up to 2040, that the trend of increase from 1985 to 2005 will continue till 2040. Also, 90 percent of the water consumed is considered to flow into the sewerage system. Average per capita wastewater production rates including non-domestic production are shown in Table XI-1.

Table XI-1 Per Capita Wastewater Production in 2020 and 2040

(lcd)

City	Year 2005	Year 2020	Year 2040
Zagazig	162	180	203
Bilbeis, Faqus, Abu Kebir, Minyet El Qamh	140	154	168
Other 8 Cities	111	118	125

2.2 Population Estimation

CAPMAS estimated the urban and rural populations in all Markaz in the Governorate up to the year 2040. For the estimate of wastewater production in 2020 and 2040, these population figures are used. Population in each city is shown in Table XI-2. This table shows the population densities in each year. Population densities are calculated based on the assumption that the urbanized areas in the year 2005 will remain unchanged until 2040, since population densities in 2040 are still low compared with those of the present day.

2.3 Design Flow Rates in 2020 and 2040

Wastewater production on a daily average basis are calculated by per capita wastewater production rates and projected population described in the previous sections. For the design of sewerage facilities, daily maximum flows are used for sewage treatment plants, and peak flows are used for pumping stations and sewer pipes. The same factors that are used for the estimation of these flows in 2005 are used for the estimation of those in 2020 and 2040. Daily maximum is 1.4 of daily average and peak flow is 2.0 of daily average. Infiltration is also eatimated based on the unit rate of 10 m^3/ha. Since served areas in 2020 and 2040 are considered to be same as those in 2005, infiltration flows remain the same in 2020 and 2040. Design flow rates in 2020 and 2040 are tabulated in Tables XI-3 and XI-4, respectively.

Table XI-2 Populations and Population Densities in 2020 and 2040

City	Area (ha)	Population (1,000 persons) 2020	2040	Population Density (persons/ha) 2020	2040
Zagazig	2,726	485.9	712.6	178	261
Huseiniya	253	38.8	58.3	153	232
Kafr Saqr	248	62.9	123.0	254	496
Faqus	515	101.5	153.0	196	295
Abu Kebir	444	153.5	240.8	346	542
Abu Hammad	310	72.2	138.7	233	447
Ibrahimiya	170	65.6	115.0	386	676
Hihya	265	69.3	115.7	262	437
Diarb Nigm	259	124.7	272.3	481	1,051
Bilbeis	667	298.1	567.9	447	851
Minyet El Qamh	300	130.3	241.3	434	804
Mashtul El Soak	254	67.3	111.0	265	437
Qenayat	228	71.7	119.7	314	525
Total	6,639	1,741.8	2,969.8		

Table XI-3 Design Flows in 2020

(m^3/day)

City	Daily Average	Daily Maximum	Peak Flow	Infil-tration	Design Flow for STP	Design Flow for Pipe
Zagazig	87,462	122,447	174,924	27,260	149,707	202,184
Huseiniya	4,578	6,409	9,156	2,530	8,939	11,686
Kafr Saqr	7,422	10,391	14,844	2,480	12,871	17,324
Faqus	15,631	21,883	31,262	5,150	27,033	36,412
Abu Kebir	23,639	33,095	47,278	4,440	37,535	51,718
Abu Hammad	8,520	11,928	17,040	3,100	15,028	20,140
Ibrahimiya	7,741	10,837	15,482	1,700	12,537	17,182
Hihya	8,177	11,448	16,354	2,650	14,098	19,004
Diarb Nigm	14,715	20,601	29,430	2,590	23,191	32,020
Bilbeis	45,907 (47,432)	64,270 (66,405)	91,814 (94,864)	6,670	70,940 (73,035)	98,484 (101,534)
Minyet El Qamh	20,066	28,092	40,132	3,000	31,092	43,132
Mashtul El Soak	7,941	11,117	15,882	2,540	13,657	18,442
Qenayat	8,461	11,845	16,922	2,280	14,125	19,202
Total	260,260	364,363	520,520	66,390	430,753	586,910

Note: Figures in parenthesis for Bilbeis include flows from army camp in the vicinity.

Table XI-4 Design Flows in 2040

(m^3/day)

City	Daily Average	Daily Maximum	Peak Flow	Infil-tration	Design Flow for STP	Design Flow for Pipe
Zagazig	144,654	202,521	289,316	27,260	229,781	316,576
Huseiniya	7,350	10,290	14,700	2,530	12,820	17,230
Kafr Saqr	15,375	21,525	30,750	2,480	24,005	33,230
Faqus	25,704	35,986	51,408	5,150	41,136	56,558
Abu Kebir	40,454	56,636	80,908	4,440	61,076	85,348
Abu Hammad	17,338	24,273	34,676	3,100	27,373	37,776
Ibrahimiya	14,375	20,125	28,750	1,700	21,825	30,450
Hihya	14,463	20,248	28,926	2,650	22,898	31,576
Diarb Nigm	34,038	47,653	68,076	2,590	50,243	70,666
Bilbeis	95,407 (96,936)	133,570 (135,710)	190,814 (193,872)	6,670	140,240 (142,380)	197,484 (200,542)
Minyet El Qamh	40,538	56,753	81,076	3,000	59,753	84,076
Mashtul El Soak	13,875	19,425	27,750	2,540	21,965	30,290
Qenayat	14,963	20,948	29,926	2,280	23,228	32,206
Total	478,538	669,953	957,076	66,390	736,343	1,023,466

Note: Figures in parenthesis for Bilbeis include flows from army camp in the vicinity.

APPENDIX - XII

ORGANIZATION CHARTS OF MARAKAZ

APPENDIX - XII

ORGANIZATION CHARTS OF MARAKAZ

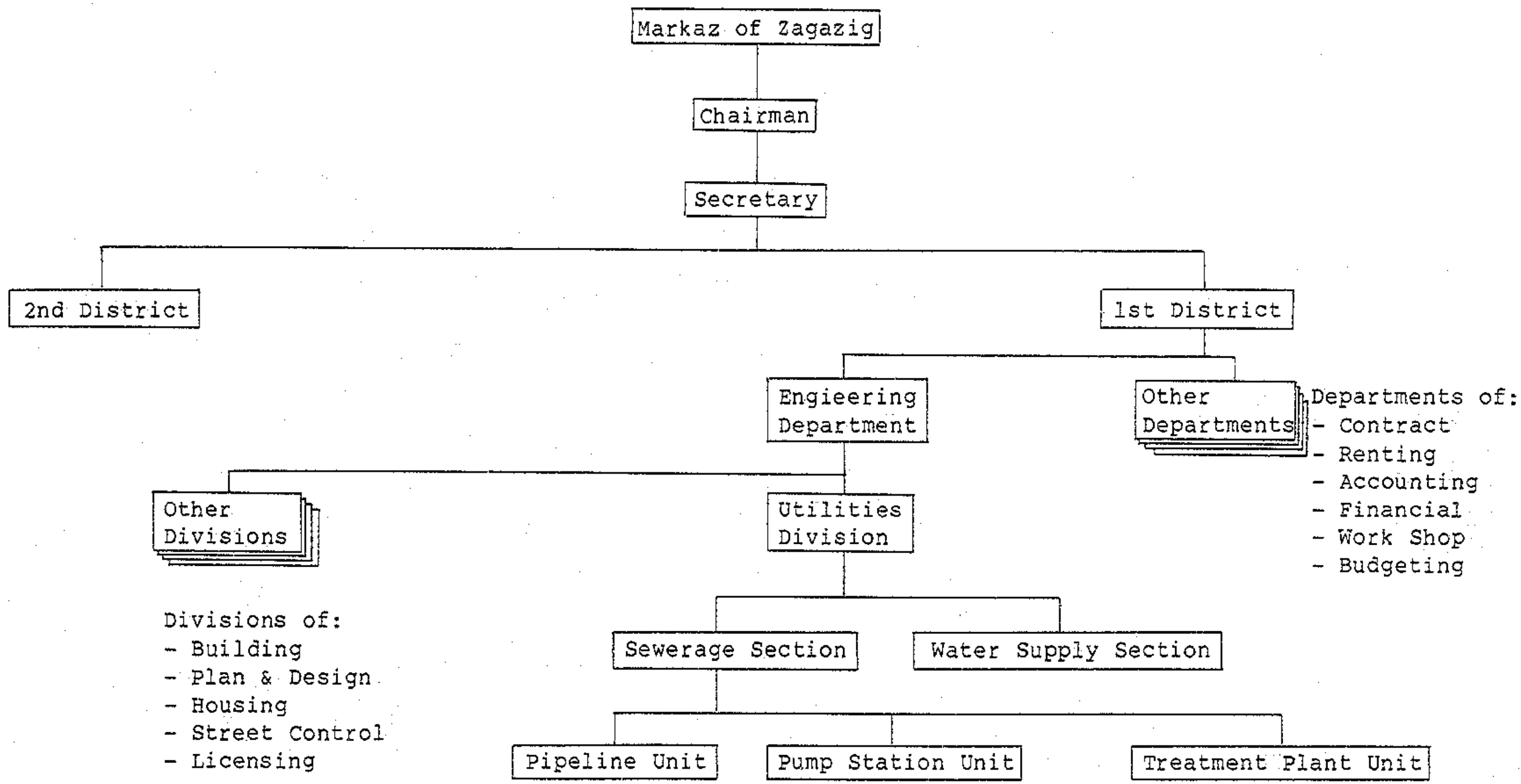
Table of Contents

List of Figures

1. Intrudoction

The organization charts of the existing functional units related to sewerage works in all Marakaz of Sharqiya Governorate are shown in the following figures.

The responsibilities of all units include operation and maintenance, minor rehabilitations and repair works of the sewerage related facilities in the respective Markaz.



Note: The functional framework under 2nd Distric is similar to that under the 1st District excluding the Treatment Plant Unit.

Figure XII-1 Sewerage Works Organization of Markaz of Zagazig

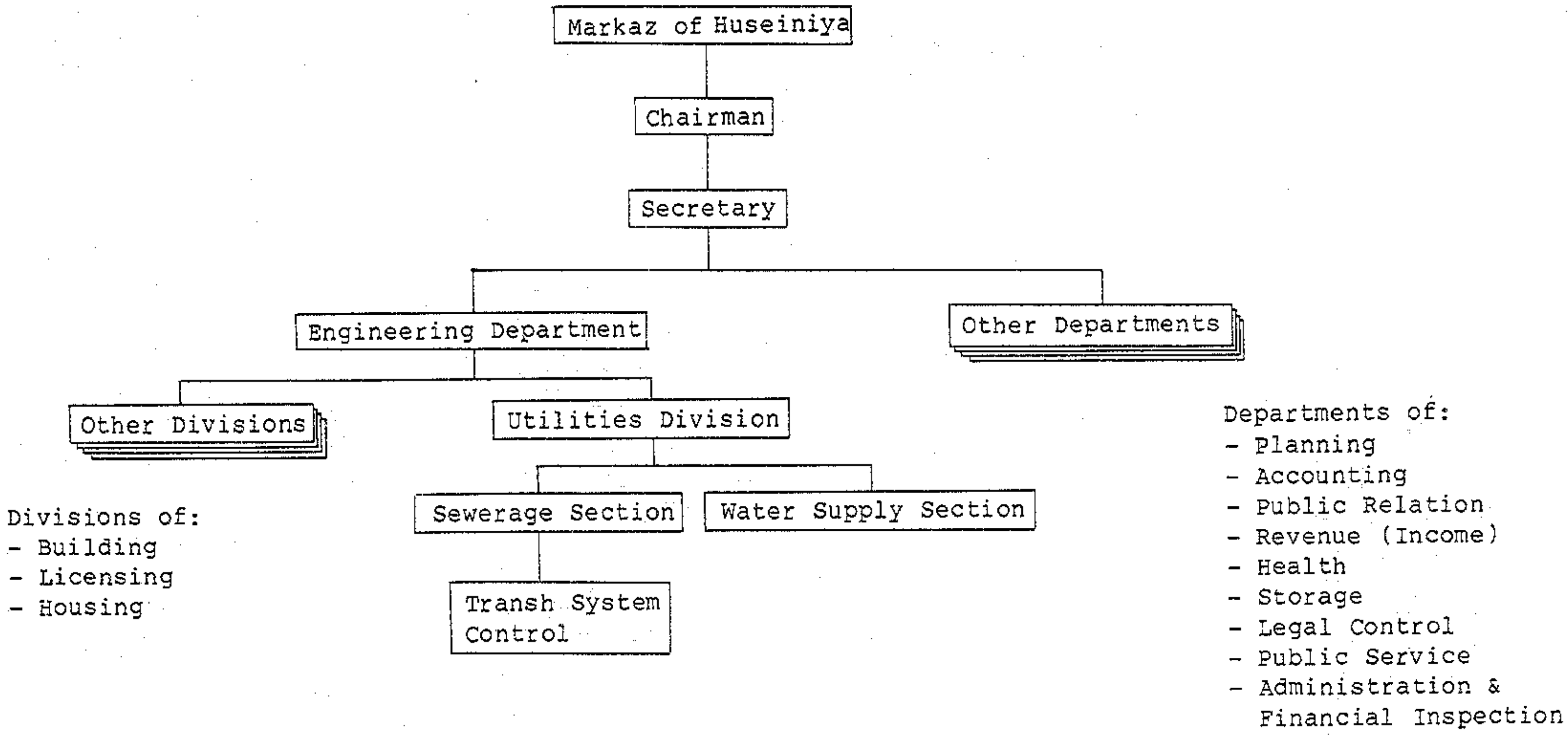


Figure XII-2 Sewerage Works Organization in Markaz of Huseiniya

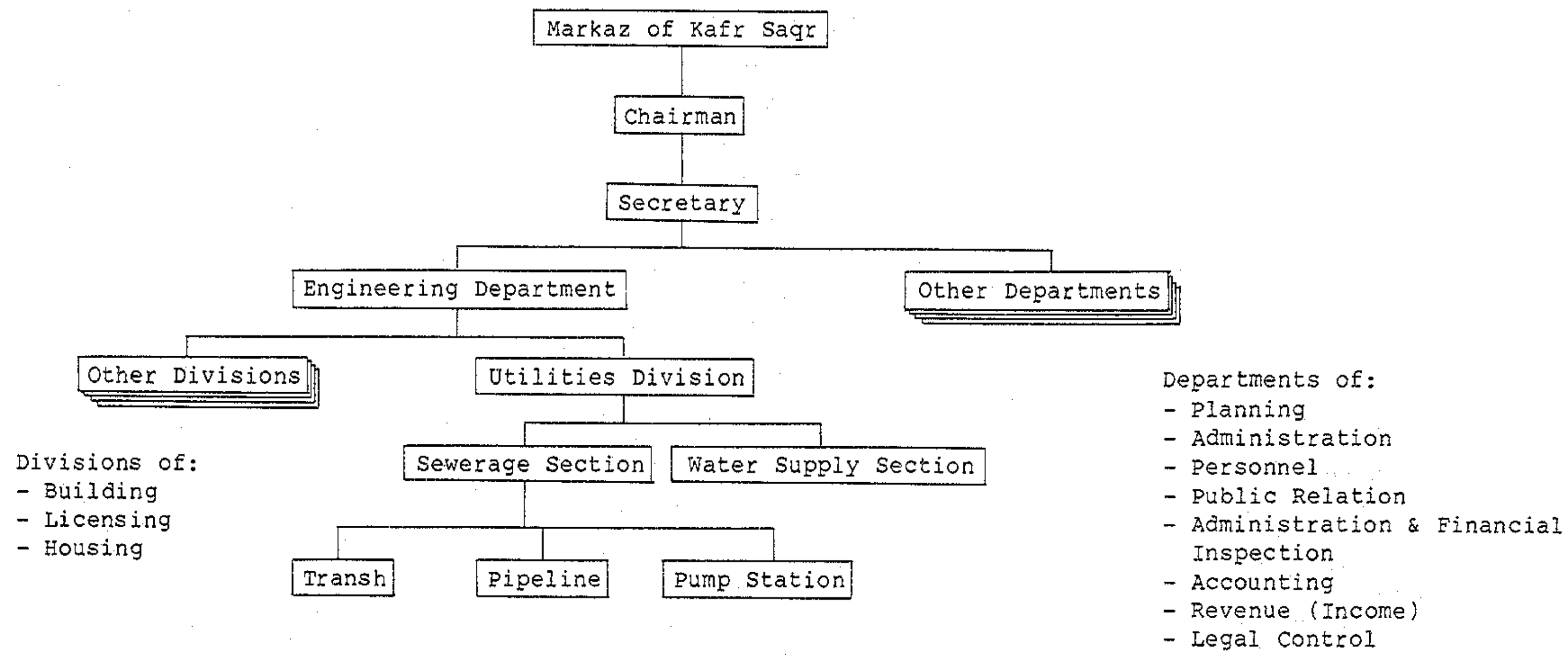


Figure XII-3 Sewerage Works Organization in Markaz of Kafr Saqr

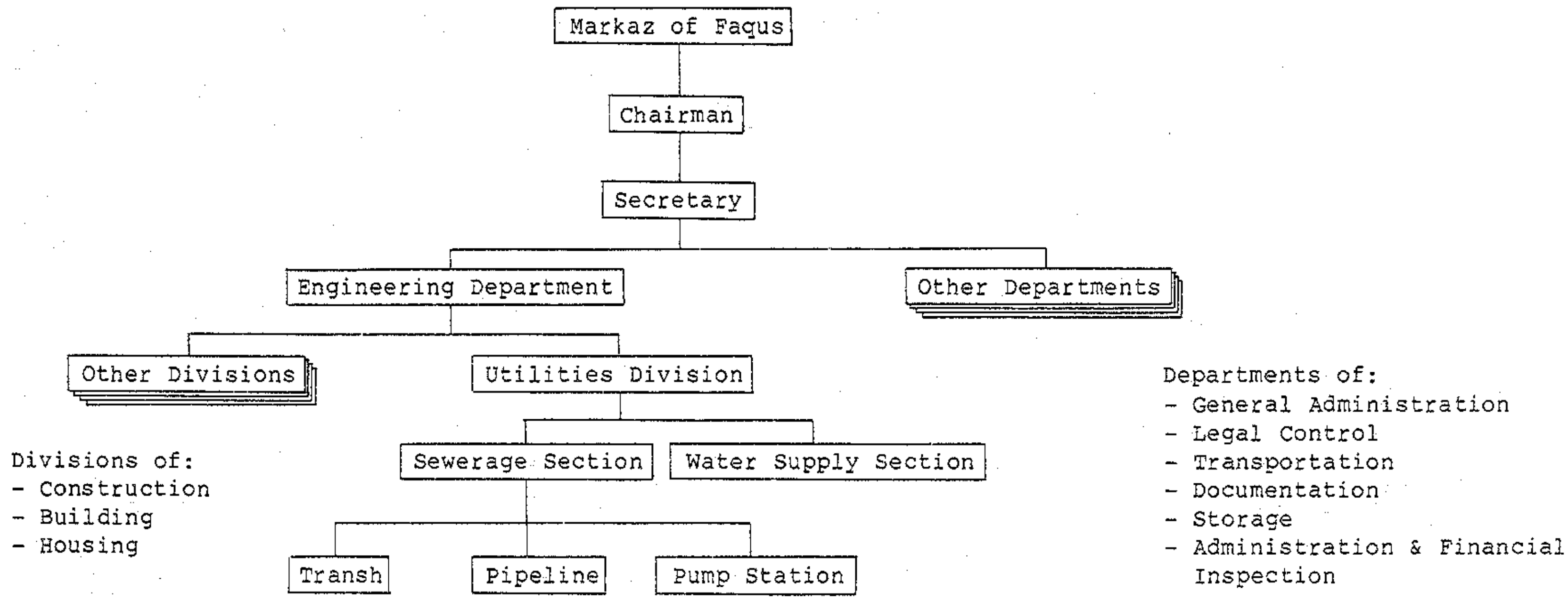


Figure XII-4 Sewerage Works Organization in Markaz of Faqus

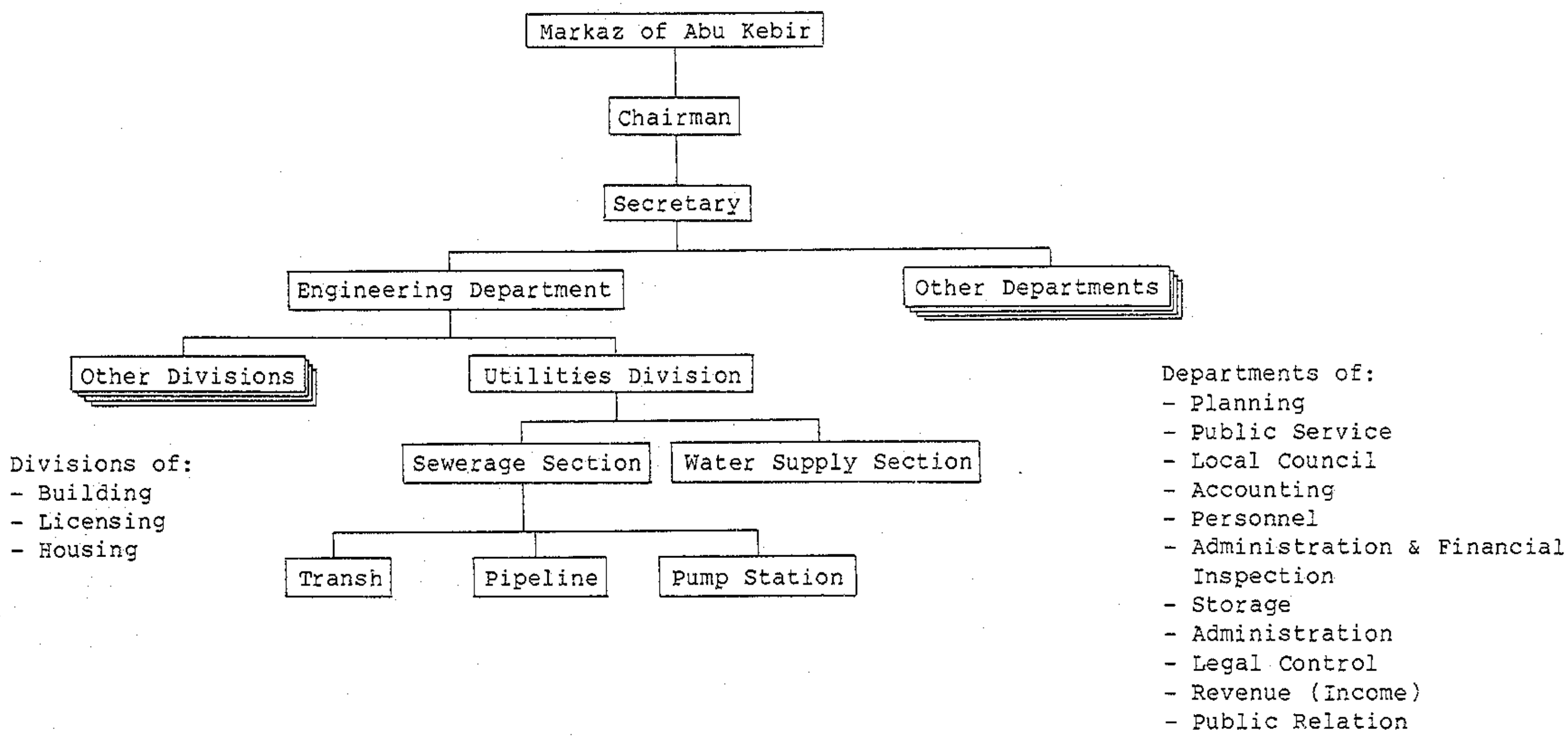


Figure XII-5 <u>Sewerage Works Organization in Markaz of Abu Kebir</u>

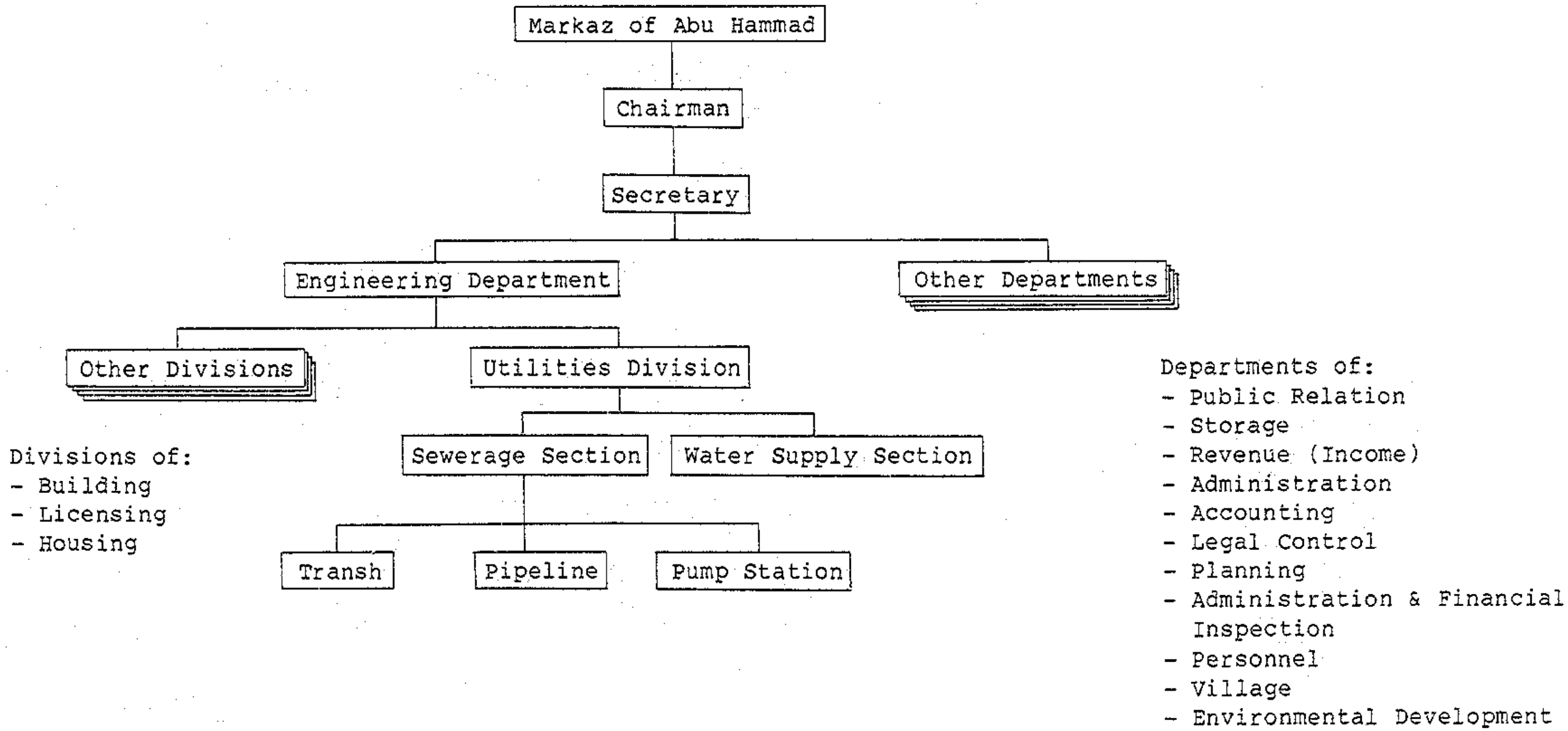


Figure XII-6 Sewerage Works Organization in Markaz of Abu Hammad

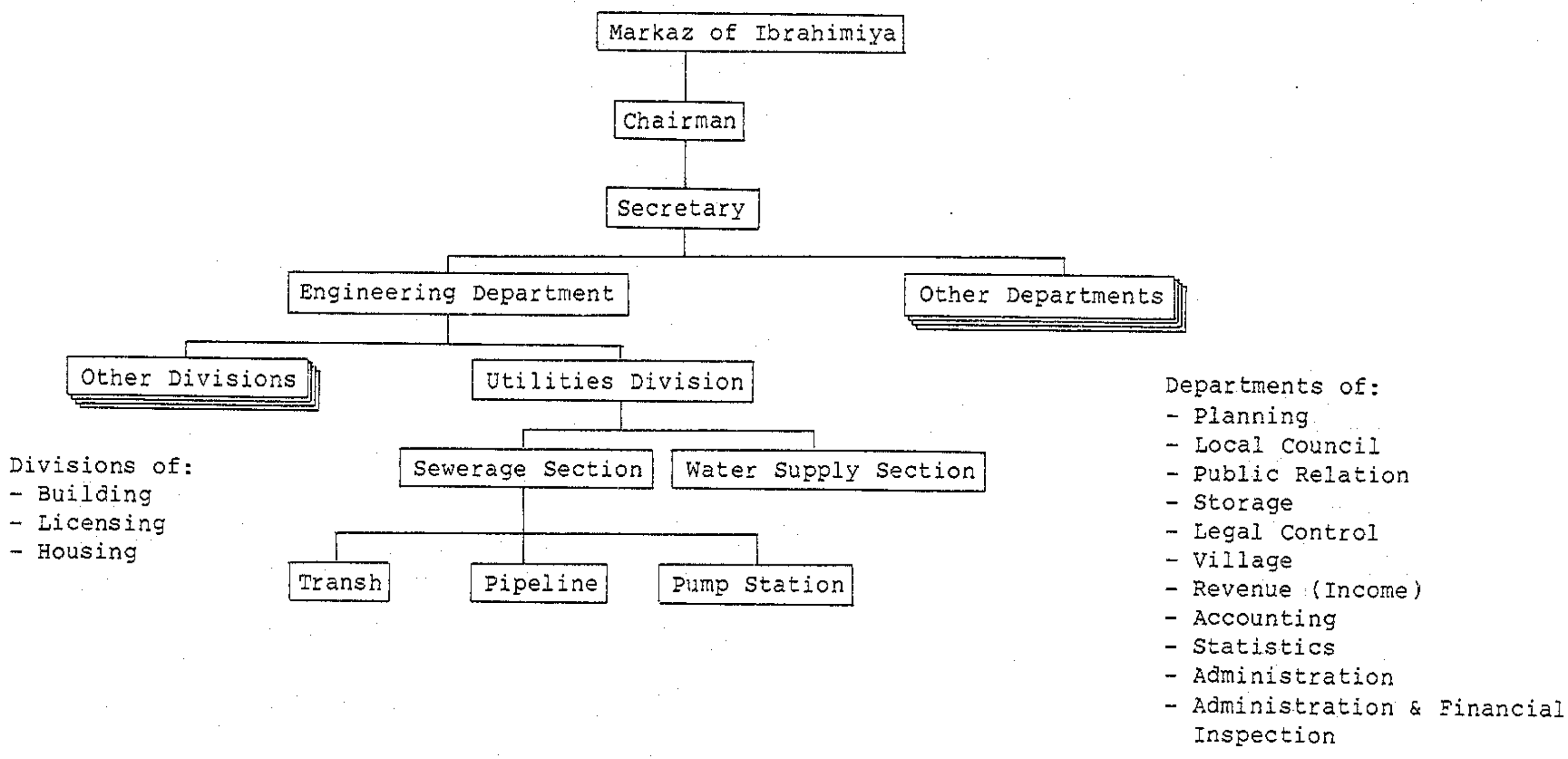


Figure XII-7 <u>Sewerage Works Organization in Markaz of Ibrahimiya</u>

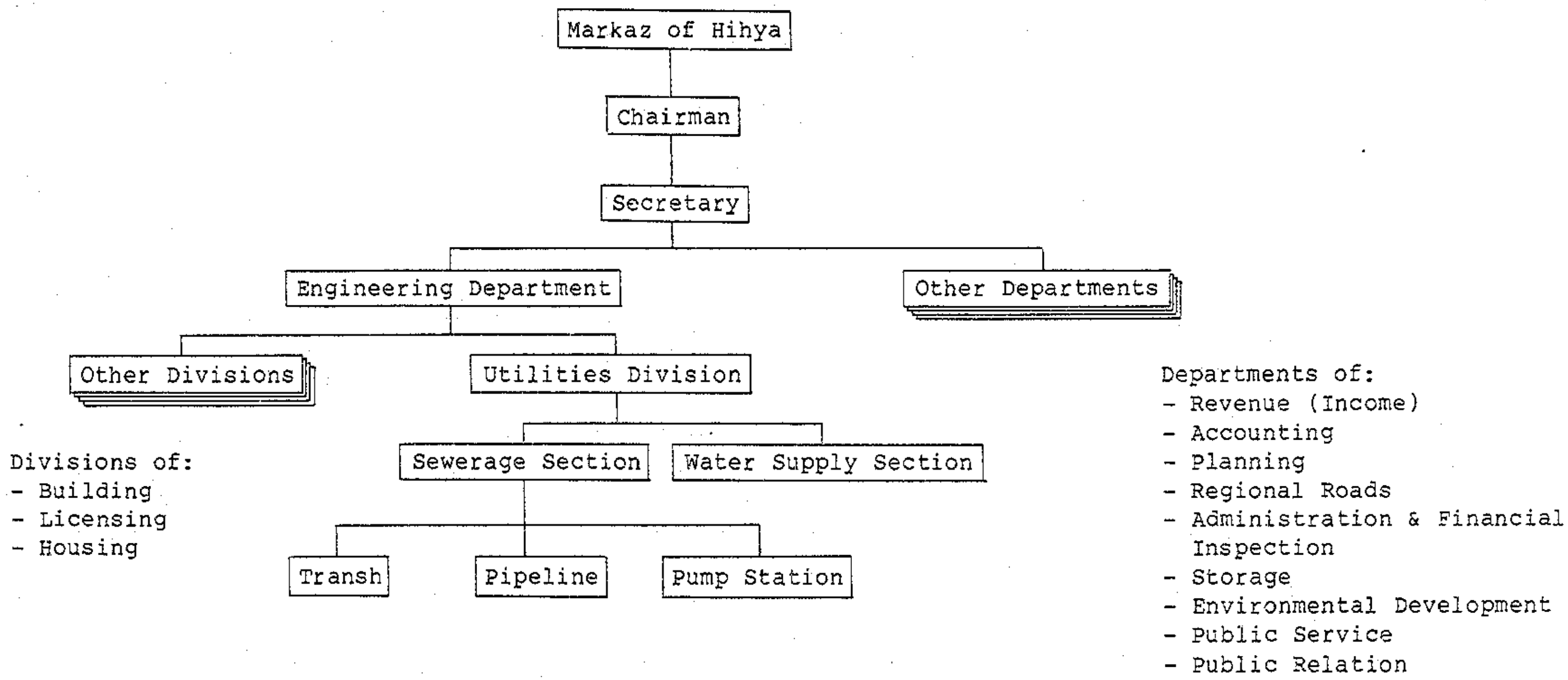


Figure XII-8 Sewerage Works Organization in Markaz of Hihya

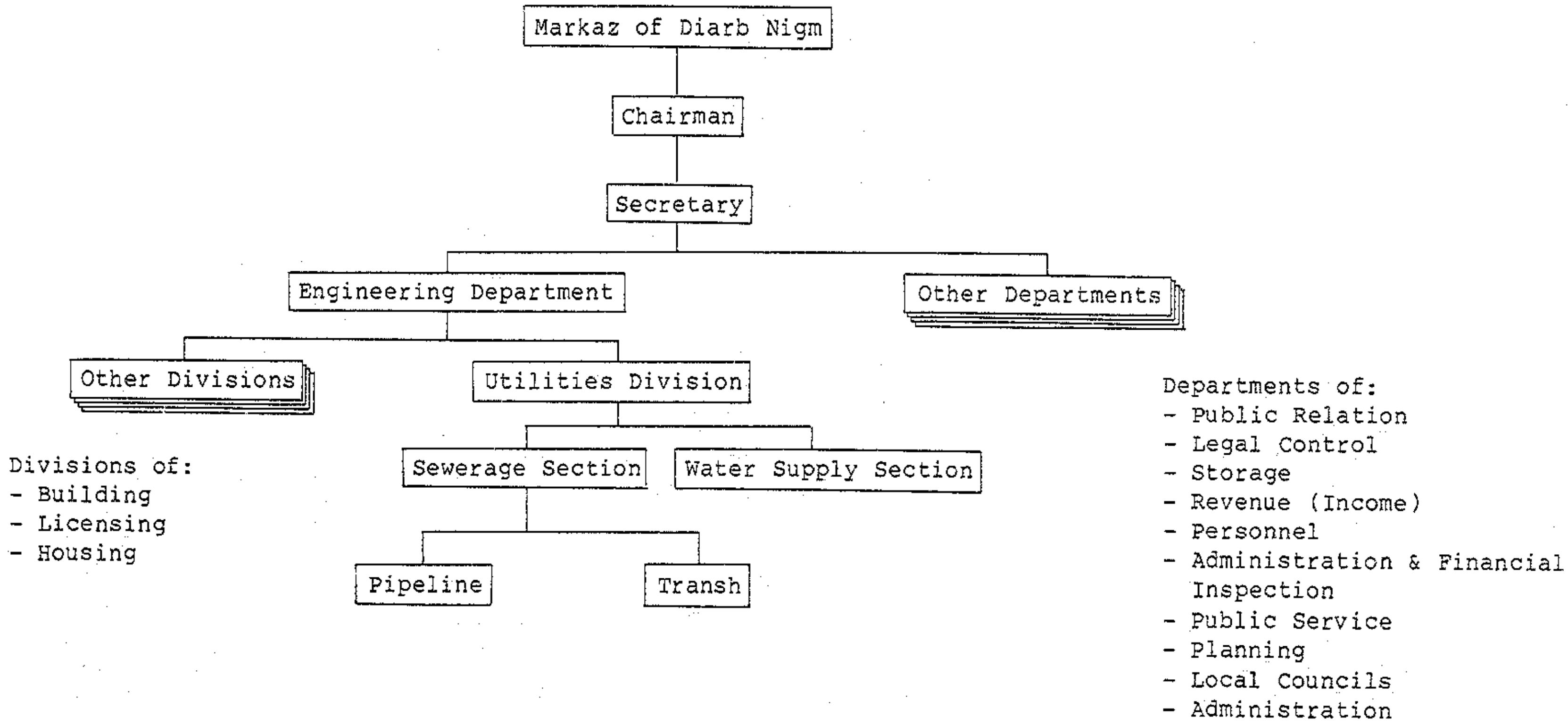


Figure XII-9 Sewerage Works Organization in Markaz of Diarb Nigm

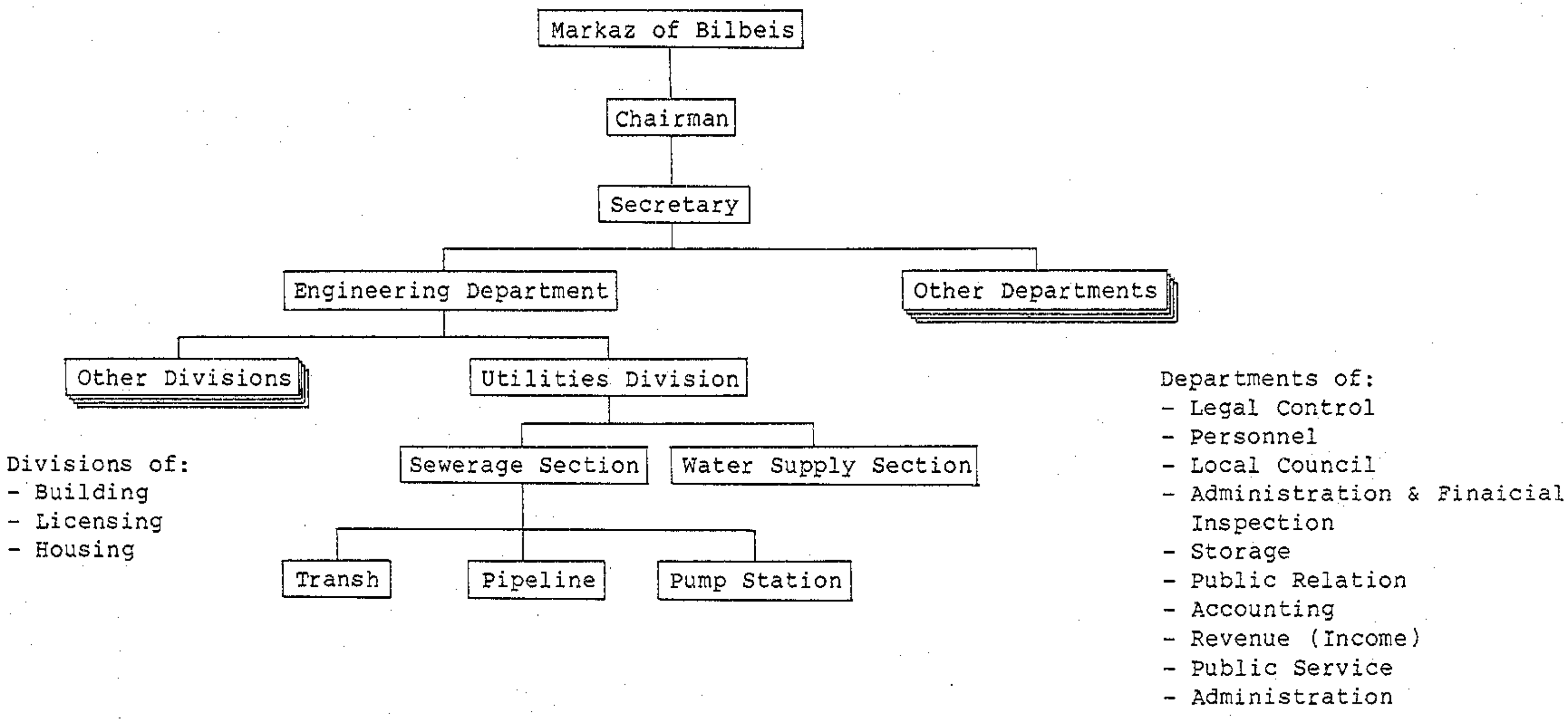


Figure XII-10 Sewerage Works Organization in Markaz of Bilbeis

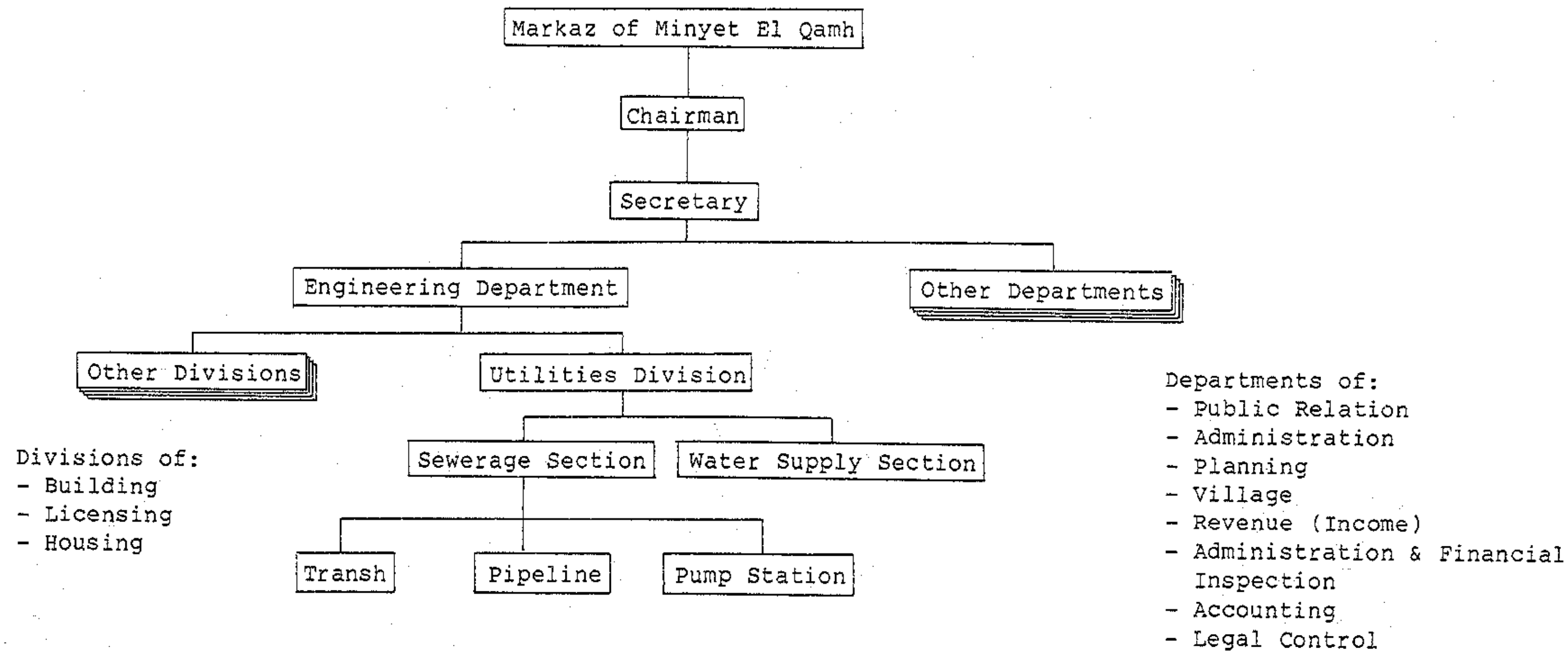


Figure XII-11 Sewerage Works Organization in Markaz of Minyet El Qamh

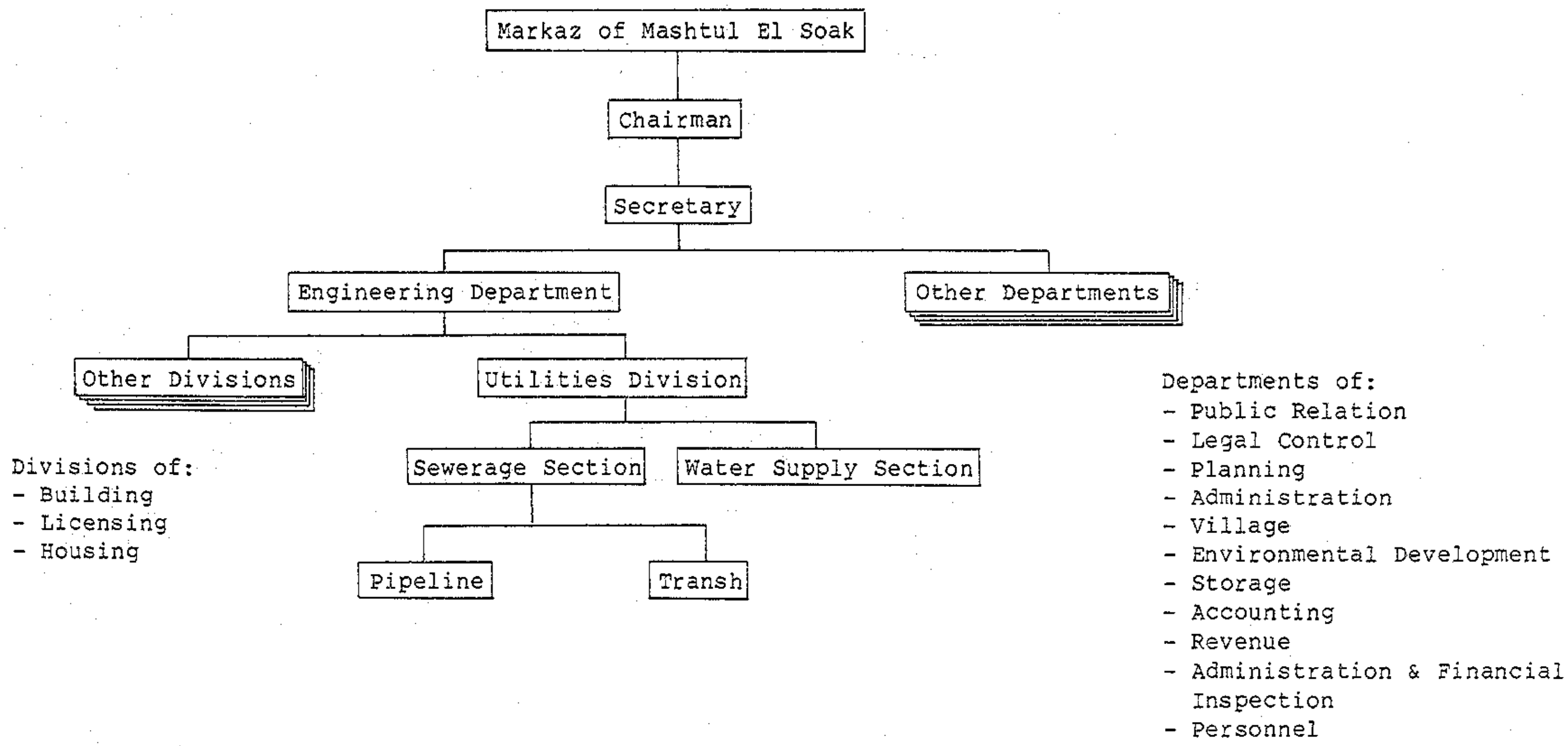


Figure XII-12 Sewerage Works Organization in Markaz of Mashtul El Soak

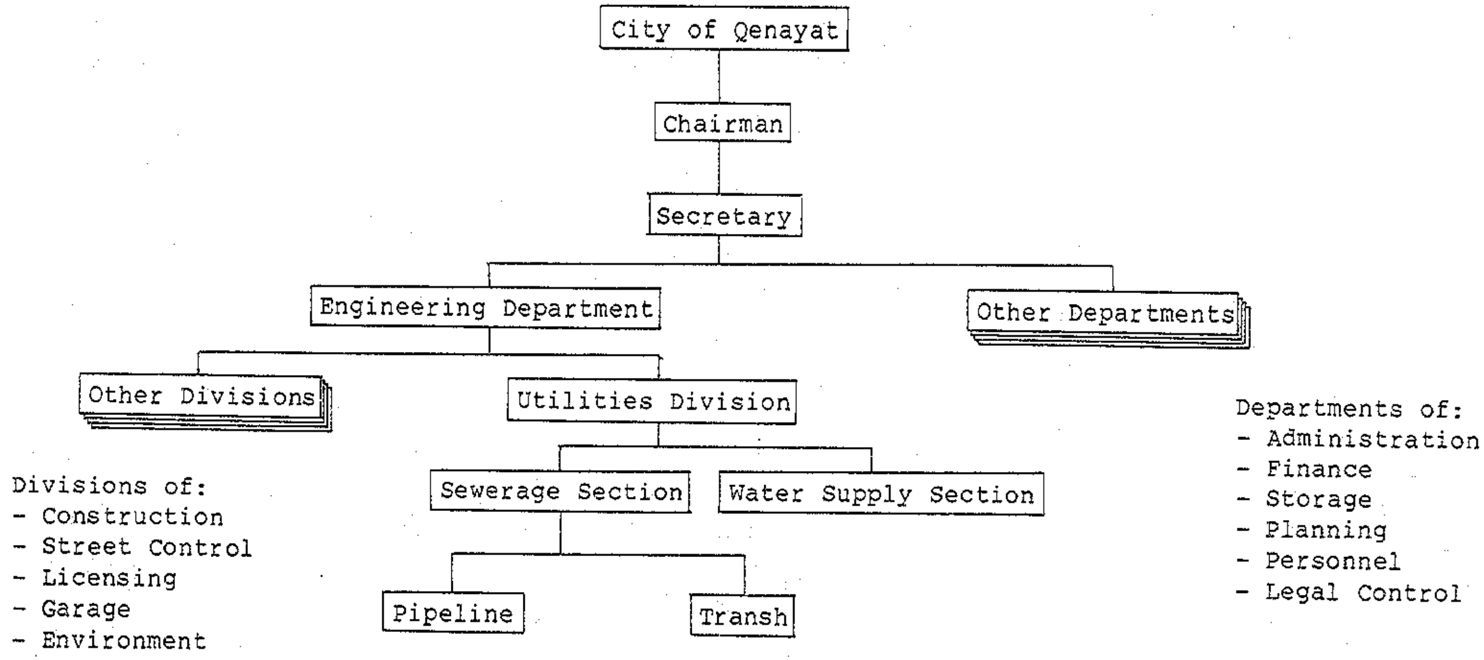


Figure XII-13 Sewerage Works Organization in Qenayat City

APPENDIX - XIII

PUBLIC HEALTH AND SANITATION

APPENDIX - XIII

PUBLIC HEALTH AND SANITATION

Table of Contents

List of Tables

1. Environmental Health

1.1 Promotion of Environmental Health

In the Sharqiya Governorate, there is a strong tendency towards increased urbanization. The burden on the urban infrastructure caused by population growth alone is staggering. Provision of safe water, proper sanitation, control of environmental hazards and food safety are areas of concern for the Governorate. The size of investments needed is of particular importance.

In considering wastes, the discharge of pollutants into the environment constitutes an increasingly prevalent type of pollution in the Governorate, affecting health and the state of environment, including agriculture and fisheries, in both the highly developed areas as well as lesser developed areas.

1.2 Control of Environmental Health Hazards

Environmental hazards are posing health problems in various cities of the Governorate, particularly in those that have reached a stage of urban development that generates biological, chemical and physical pollution.

The side effects of such development are increasingly recognized as constituting threats to human health. In industrially less-developed areas, in other words, in rural areas, the pollution has increased resulting mainly from traditional sources, viz. municipal sanitary wastes including solid wastes.

Rural sanitation is lagging seriously behind both rural water supply and urban sanitation, with provision of urban water supplies were receiving most attention.

A number of activities related to the International Drinking Water Supply and Sanitation Decade (1981-1990) call for priority attention to be given to rural and other underserved population areas. In the Governorate as well as in the whole country, some recommendations were made to accelerate such activities, mainly with respect to inter-sectoral coordination, health education, community participation, public information, national data bases, human resources development, drinking water quality, sanitation and financial resources.

For the control of enviromental health hazards, cooperation between governorates in activities that aim to build up governorate capacities to handle pollution problems, as well as related training, legislative and organizational expertise, is important. It is most desirable that the Sharqiya Governorate be assisted in strengthening national institutions and by the provision and exchange of information on health hazards.

2. Environmentally Induced Diseases

2.1 General

The prevalance of this group of diseases is directy related to the level of sanitation in general and the availability of basic sanitary amenities in particular. Basic sanitary amenities include safe water supply and sanitary means for the disposal of human excreta in an area.

According to the information obtained from Ministry of Health, typhoid fever decreased from 30.9 per 100,000 in 1979 to 8.3 in 1983 in the whole country. Infectious hepatitis decreased from 61.4 per 100,000 in 1970 to 39 in 1982, and then slightly increased to 49.2 per 100,000 in 1983. It is important to note that the virus of infectious hepatitis resists the present chlorination practice.

Urinary bilharzia is fluctuaiting both among rural population and students. Generally speaking, about 25 percent of the rural population suffer from one type of intestinal parasites or another compared with 11 percent among students.

Table XIII-1 shows governorates with higher rates of hepatitis and/or typhoid than the national figures in 1983. Table XIII-2 shows number of cases of virus hepatitis, typhoid and diarrhoea isolated in hospitals in the Sharqiya Governorate in 1986 and 1987.

Table XIII-1 Provinces Showing Higher Rates of Typhoid and/or Hepatitis than the National Figures (1983)

Province	Population (000)	Inf. Hepatitis No.	Inf. Hepatitis Rate	Typhoid No.	Typhoid Rate*
Cairo	6,104	2,585	42.3	904	14.8
Alexandria	2,811	2,565	91.2	854	30.4
Port Said	378	290	76.7	13	3.4
Ismailia	249	282	113.3	-	-
Damietta	716	479	66.9	60	8.4
Giza	3,078	1,085	32.3	405	13.2
Fayoum	1,464	803	54.8	70	4.8
Asiut	2,138	1,775	83.0	388	18.1
Sohag	2,404	712	29.6	292	12.1
Aswan	772	1,213	57.1	10	1.3
Red Sea	71	44	62.0	6	8.5
Matrouh	162	96	59.3	46	38.4
N. Sinai	148	70	46.3	4	2.7
National	45,886	17,824	38.8	4,010	8.3

* Rates: per 100,000 population

Table XIII-2 <u>Number of Cases of Virus Hepatitis, Typhoid and Diarrhoea Isolated in Hospitals in the Sharqiya Governorate (1986 and 1987)</u>

Hospital	1986			1987			Infants mortality (under 5 years)	
	Virus hepatitis	Typhoid	Diarrhoea	Virus hepatitis	Typhoid	Diarrhoea	1986	1987
Zagazig	151	47	5	146	9	8	1,480	1,551
Minyet El Qamh	42	6	14	10	0	13	979	878
Bilbeis	36	3	12	64	1	4	840	841
Faqus	112	4	1	179	6	3	868	736

2.2 Important Related Diseases

(1) Acute diarrhoeal diseases remain the most important cause of morbidity and mortality among infants and young children in most areas of the Governorate, and therefore development programs for the control of diarrhoeal diseases have continued to be one of the priority areas in the Governorate.

The control of diarrhoeal diseases is largely divided into two, viz. a) health service activities; and b) operational research. The main emphasis is being laid on program planning, and on its extension and evaluation. Plans of operation include training for all levels of health workers and the production of oral rehydration salts (ORS).

Strategy in diarrhoeal disease control is based mainly on widespread implementation of oral rehydration salts. The other strategies, viz. improvement in maternal and child health practices, breastfeeding, environmental sanitation, personnel and domestic hygiene and epidemic control are being given due attention, and are gradually being implemented in the Governorate.

(2) Schistosomiasis remains as one of the most important and serious public health problems in the Governorate, owing to its impact on the social well-being and on the economic activities and to the role it plays in causing ill-health.

Intervention techniques in attempts to control schistosomiasis by controlling transmission of the disease are beyond the financial, technical and personnel resources in the Governorate, even though only some parts of the country are affected. The discovery of safe, well-tolerated and highly effective oral drugs and the low-cost diagnostic techniques for use in rural areas are producing dramatic results.

(3) Parasitic diseases

Throughout the Governorate, parasitic diseases remain among the most important and most serious public health problems, with comparatively high prevalance rates for major protozoal and helminthic infections. In order of importance, this group of diseases includes schistosomiasis, trypanosomiasis, lymphatic filariasis and onchocerciasis. The major constraint hindering the control of these parasitic deseases is the lack of sufficient competent personnel able to carry out the ongoing national control programs. In this connection, the Governorate as well as Ministry of Health have been paying increasing attention on the planning and evaluation of health manpower so urgenty needed to bring these diseases under control.

3. Sanitation

3.1 Status of Sanitation

In the Sharqiya Governorate, sanitation status is largely divided into three categories as given below.:

i) City public water supplies have always received attention, on the contrary sewage disposal and sludge disposal, especially in rural areas, have generally been left to the individual householder. Due to higher population densities and the introduction of high-rise buildings, individual facilities have become inappropriate so much as that septic tanks overflowning. The exisiting sewers have not been designed for extension to newly builtup communities.

ii) With the rapid growth of industrial undertakings in and around the cities, further problems have arisen. It is found that industrial wastes are flowing into the sewerage system, drains and canals.

iii) Efforts for lowering groundwater levels were initially successful, but of late, drains have been slowly converted into sewers to carry household sewage and sludge.

3.2 Wastewater and Sewerage Systems

The existing plant is overloaded and its efficiency is unsatisfactory. Not uncommonly, the effluent is discharged into the receiving agricultural drains without any significant reduction in the organic loads.

As a result of this practice, the agricultural drains are heavily polluted threatening the legitimate water users of water bodies.

It is very important to note that the capacity of the existing sewerage systems is insufficient to transport the quantity of wastewater producted. This will result in overflow of sewage in the residential areas, causing more immediate health hazards.

APPENDIX - XIV

FINANCIAL AND ECONOMIC ANALYSIS DATA

APPENDIX - XIV

FINANCIAL AND ECONOMIC ANALYSIS DATA

Table of Contents

List of Tables

List of Figures

1. Introduction

This Appendix aims to provide the supporing data and results of the relevant project evaluation works for the financial and economic analysis of the proposed project.

Figure XIV-1 Flow Chart for Project Evaluation

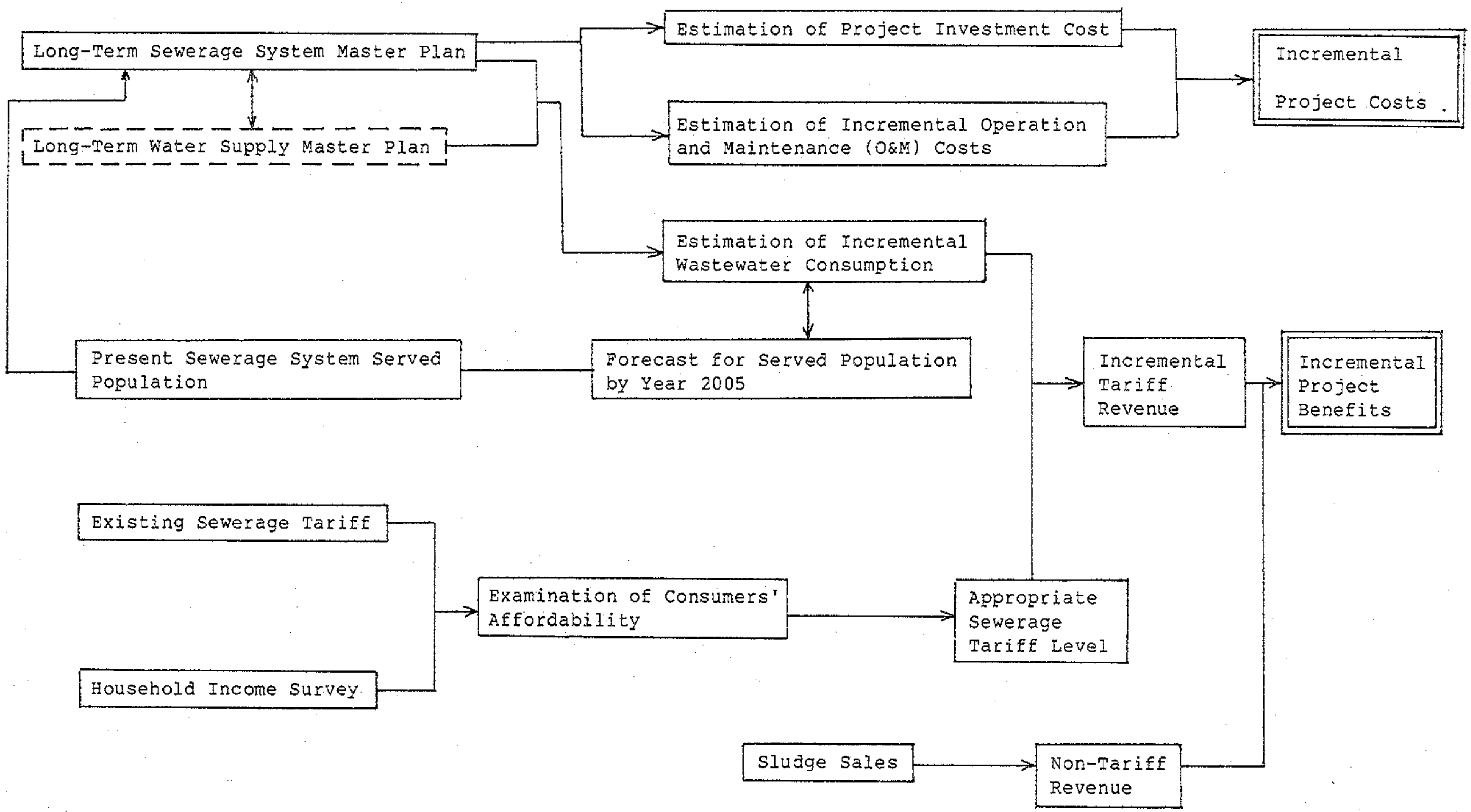


Table XIV-1 Repayment Schedule for Debt Service

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
LOANED AMOUNT	2,870.00	2,870.00	5,566.00	5,568.00	3,383.00	3,374.00					
INTEREST	100.45	204.42	406.38	615.48	755.43	899.96	931.46	964.06	997.80	1,032.73	983.55
BALANCE BROUGHT FORWARD	0.00	2,970.45	6,044.87	12,017.25	18,200.73	22,339.16	26,613.12	27,544.58	28,508.64	29,506.44	28,101.37
REPAYMENT										2,437.79	2,388.62
BALANCE CARRIED FORWARD	2,970.45	6,044.87	12,017.25	18,200.73	22,339.16	26,613.12	27,544.58	28,508.64	29,506.44	28,101.37	26,696.31

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
934.37	885.19	836.02	786.84	737.66	688.48	639.31	590.13	540.95	491.77	442.60	393.42
26,696.31	25,291.24	23,886.17	22,481.10	21,076.03	19,670.96	18,265.89	16,860.82	15,455.76	14,050.69	12,645.62	11,240.55
2,339.44	2,290.26	2,241.08	2,191.91	2,142.73	2,093.55	2,044.37	1,995.20	1,946.02	1,896.84	1,847.67	1,798.49
25,291.24	23,886.17	22,481.10	21,076.03	19,670.96	18,265.89	16,860.82	15,455.76	14,050.69	12,645.62	11,240.55	9,835.48

2012	2013	2014	2015	2016	2017	2018
344.24	295.06	245.89	196.71	147.53	98.35	49.18
9,835.48	8,430.41	7,025.34	5,620.27	4,215.21	2,810.14	1,405.07
1,749.31	1,700.13	1,650.96	1,601.78	1,552.60	1,503.42	1,454.25
8,430.41	7,025.34	5,620.27	4,215.21	2,810.14	1,405.07	0.00

Table XIV-2 Financial Projection (Case-1) for Proposed Sewerage Project

	1991/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	1999/2000	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06-2034/35
Incremental Water Volume (m3)	24,699	26,402	28,024	29,687	31,350	31,593	31,877	32,201	32,486	32,769	33,012	33,256	33,580	33,823	34,067
Average Tariff (pts/m^3)	14	35	35	35	35	35	49	49	49	49	49	63	63	63	63
Surcharge Ratio (%)	10	10	10	10	10	10	20	20	20	20	20	20	20	20	20
Sewerage Revenue (LE 1,000)	345.8	924.1	980.8	1,039.0	1,097.3	1,105.8	3,123.9	3,155.7	3,183.6	3,211.4	3,235.2	4,190.3	4,231.1	4,261.7	4,292.4
Non-Tariff Revenue (LE 1,000)	-	-	-	-	213.0	222.0	234.0	243.0	252.0	258.0	267.0	276.0	288.0	297.0	300.0
Total Revenue	345.8	924.1	980.8	1,039.0	1,310.3	1,327.8	3,357.9	3,398.7	3,435.6	3,469.4	3,502.2	4,466.3	4,519.1	4,558.7	4,592.4
Direct Operating Expenses (LE 1,000)	332.0	362.0	390.0	489.0	653.0	762.0	809.0	957.0	1,018.0	1,126.0	1,258.0	1,315.0	1,529.0	1,658.0	1,848.0
Net Income (deficit) (LE 1,000)	13.8	562.1	590.8	550.0	657.3	565.8	2,548.9	2,441.7	2,417.6	2,343.4	2,244.2	3,151.3	2,990.1	2,900.7	2,744.4

Table XIV-3 Financial Projection (Case-2) for Proposed Sewerage Project

	1991/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	1999/2000	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06-2034/35
Incremental Water Volume (m3)	24,699	26,402	28,024	29,687	31,350	31,593	31,877	32,201	32,486	32,769	33,012	33,256	33,580	33,823	34,067
Average Tariff (pts/m^3)	14	35	35	35	35	35	49	49	49	49	49	63	63	63	63
Surcharge Ratio (%)	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Sewerage Revenue (LE 1,000)	345.8	2,772.2	2,942.5	3,117.1	3,291.8	3,317.3	4,685.9	4,733.5	4,775.4	4,817.0	4,852.8	6,285.4	6,346.6	6,392.5	6,438.7
Non-Tariff Revenue (LE 1,000)	-	-	-	-	213.0	222.0	234.0	243.0	252.0	258.0	267.0	276.0	288.0	297.0	300.0
Total Revenue	345.8	2,772.2	2,942.5	3,117.1	3,504.8	3,539.3	4,919.9	4,976.5	5,027.4	5,075.0	5,119.8	6,561.4	6,634.6	6,689.5	6,738.7
Direct Operating Expenses (LE 1,000)	332.0	362.0	390.0	489.0	653.0	762.0	809.0	957.0	1,018.0	1,126.0	1,258.0	1,315.0	1,529.0	1,658.0	1,848.0
Net Income (deficit) (LE 1,000)	13.8	2,410.2	2,552.5	2,628.1	2,851.8	2,777.3	4,110.9	4,019.5	4,009.4	3,949.0	3,861.8	5,246.4	5,105.6	5,031.5	4,890.7

Table XIV-4 Discounted Cash Flow of Project Incremental Costs and Benefits (Base Case)

BASE CASE

Discounted Cash Flow of Project Incremental Costs and Benefits

B-C -85261.71

B/C 0.0889232

IRR -0.022011

		Investment (LE1,000)	CostO&M Costs	Total	Incre.Water Consumption (1000m3)	Water Tariff Revenue	Sewerage Revenue	Non-Tariff Revenue (LE1000)	Total	
0	1989/90	18,774		18,774					0.00	-18774
1	1990/91	18,622	0	18,622					0.00	-18622
2	1991/92	31,065	332	31,397	24,699	3457.86	345.79		345.79	-31051.21
3	1992/93	31,064	362	31,426	26,402	7392.56	739.26		739.26	-30686.74
4	1993/94	22,294	390	22,684	28,024	7846.72	784.67		784.67	-21899.32
5	1994/95	22,283	489	22,772	29,687	8312.36	831.24		831.24	-21940.76
6	1995/96		653	653	31,350	8778.00	877.80	213	1090.80	437.8
7	1996/97		762	762	31,593	8846.04	884.60	222	1106.60	344.604
8	1997/98		809	809	31,877	13388.34	1338.83	234	1572.83	763.834
9	1998/99		957	957	32,201	13524.42	1352.44	243	1595.44	638.442
10	1999/00		1,018	1,018	32,486	13644.12	1364.41	252	1616.41	598.412
11	2000/01		1,126	1,126	32,769	13762.98	1376.30	258	1634.30	508.298
12	2001/02		1,258	1,258	33,012	13865.04	1386.50	267	1653.50	395.504
13	2002/03		1,315	1,315	33,256	18623.36	3724.67	276	4000.67	2685.672
14	2003/04		1,529	1,529	33,580	18804.80	3760.96	288	4048.96	2519.96
15	2004/05		1,658	1,658	33,823	18940.88	3788.18	297	4085.18	2427.176
16	2005/06		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
17	2006/07		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
18	2007/08		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
19	2008/09		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
20	2009/10		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
21	2010/11		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
22	2011/12		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
23	2012/13		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
24	2013/14		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
25	2014/15		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
26	2015/16		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
27	2016/17		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
28	2017/18		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
29	2018/19		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
30	2019/20		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
31	2020/21		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
32	2021/22		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
33	2022/23		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
34	2023/24		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
35	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
36	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
37	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
38	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
39	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
40	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
41	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
42	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
43	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
44	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
45	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504

Table XIV-5 Discounted Cash Flow of Project Incremental Costs and Benefits (Case 1)

CASE-1

Discounted Cash Flow of Project Incremental Costs and Benefits

B-C -82317.39

B/C 0.1203852

IRR -0.012463

		Investment Cost (LE1,000)	O&M Costs	Total	Incre.Water Consumption (1000m3)	Water Tariff Revenue	Sewerage Revenue	Non-Tariff Revenue (LE1000)	Total	
0	1989/90	18,774		18,774					0.00	-18774
1	1990/91	18,622	0	18,622					0.00	-18622
2	1991/92	31,065	332	31,397	24,699	3457.86	345.79		345.79	-31051.21
3	1992/93	31,064	362	31,426	26,402	9240.70	924.07		924.07	-30501.93
4	1993/94	22,294	390	22,684	28,024	9808.40	980.84		980.84	-21703.16
5	1994/95	22,283	489	22,772	29,687	10390.45	1039.04		1039.04	-21732.95
6	1995/96		653	653	31,350	10972.50	1097.25	213	1310.25	657.25
7	1996/97		762	762	31,593	11057.55	1105.76	222	1327.76	565.755
8	1997/98		809	809	31,877	15619.73	3123.95	234	3357.95	2548.946
9	1998/99		957	957	32,201	15778.49	3155.70	243	3398.70	2441.698
10	1999/00		1,018	1,018	32,486	15918.14	3183.63	252	3435.63	2417.628
11	2000/01		1,126	1,126	32,769	16056.81	3211.36	258	3469.36	2343.362
12	2001/02		1,258	1,258	33,012	16175.88	3235.18	267	3502.18	2244.176
13	2002/03		1,315	1,315	33,256	20951.28	4190.26	276	4466.26	3151.256
14	2003/04		1,529	1,529	33,580	21155.40	4231.08	288	4519.08	2990.08
15	2004/05		1,658	1,658	33,823	21308.49	4261.70	297	4558.70	2900.698
16	2005/06		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
17	2006/07		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
18	2007/08		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
19	2008/09		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
20	2009/10		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
21	2010/11		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
22	2011/12		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
23	2012/13		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
24	2013/14		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
25	2014/15		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
26	2015/16		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
27	2016/17		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
28	2017/18		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
29	2018/19		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
30	2019/20		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
31	2020/21		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
32	2021/22		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
33	2022/23		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
34	2023/24		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
35	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
36	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
37	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
38	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
39	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
40	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
41	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
42	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
43	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
44	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
45	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442

Table XIV-6 Discounted Cash Flow of Project Incremental Costs and Benefits (Case 2)

CASE-2

Discounted Cash Flow of Project Incremental Costs and Benefits

B-C -73810.11

B/C 0.2112910

IRR 0.0140209

		Investment Cost (LE1,000)	O&M Costs	Total	Incre.Water Consumption (1000m3)	Water Tariff Revenue	Sewerage Revenue	Non-Tariff Revenue (LE1000)	Total	
0	1989/90	18,774		18,774					0.00	-18774
1	1990/91	18,622	0	18,622					0.00	-18622
2	1991/92	31,065	332	31,397	24,699	3457.86	345.79		345.79	-31051.21
3	1992/93	31,064	362	31.426	26,402	9240.70	2772.21		2772.21	-28653.79
4	1993/94	19,369	390	19,759	28,024	9808.40	2942.52		2942.52	-16816.48
5	1994/95	19,365	489	19,854	29,687	10390.45	3117.14		3117.14	-16736.86
6	1995/96		653	653	31,350	10972.50	3291.75	213	3504.75	2851.75
7	1996/97		762	762	31,593	11057.55	3317.27	222	3539.27	2777.265
8	1997/98		809	809	31,877	15619.73	4685.92	234	4919.92	4110.919
9	1998/99		957	957	32,201	15778.49	4733.55	243	4976.55	4019.547
10	1999/00		1,018	1,018	32,486	15918.14	4775.44	252	5027.44	4009.442
11	2000/01		1,126	1,126	32,769	16056.81	4817.04	258	5075.04	3949.043
12	2001/02		1,258	1,258	33,012	16175.88	4852.76	267	5119.76	3861.764
13	2002/03		1,315	1,315	33,256	20951.28	6285.38	276	6561.38	5246.384
14	2003/04		1,529	1,529	33,580	21155.40	6346.62	288	6634.62	5105.62
15	2004/05		1,658	1,658	33,823	21308.49	6392.55	297	6689.55	5031.547
16	2005/06		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
17	2006/07		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
18	2007/08		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
19	2008/09		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
20	2009/10		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
21	2010/11		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
22	2011/12		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
23	2012/13		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
24	2013/14		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
25	2014/15		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
26	2015/16		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
27	2016/17		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
28	2017/18		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
29	2018/19		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
30	2019/20		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
31	2020/21		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
32	2021/22		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
33	2022/23		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
34	2023/24		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
35	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
36	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
37	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
38	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
39	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
40	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
41	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
42	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
43	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
44	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663
45	2024/25		1,848	1,848	34,067	21462.21	6438.66	300	6738.66	4890.663

Table XIV-7 Discounted Cash Flow of Project Incremental Costs and Benefits (Case 3)

CASE-3

Discounted Cash Flow of Project Incremental Costs and Benefits

B-C: -70612.05

B/C: 0.1054269

IRR: -0.015505

	Year	Investment Costs (LE1,000)	O&M Costs	Total	Incre.Water Consumption (1000m3)	Water Tariff Revenue	Sewerage Revenue	Non-Tariff Revenue (LE1000)	Total	
0	1989/90	15,904		15,904					0.00	-15904
1	1990/91	15,752	0	15,752					0.00	-15752
2	1991/92	25,499	332	25,831	24,699	3457.86	345.79		345.79	-25485.21
3	1992/93	25,496	362	25,858	26,402	7392.56	739.26		739.26	-25118.74
4	1993/94	18,911	390	19,301	28,024	7846.72	784.67		784.67	-18516.32
5	1994/95	18,909	489	19,398	29,687	8312.36	831.24		831.24	-18566.76
6	1995/96		653	653	31,350	8778.00	877.80	213	1090.80	437.8
7	1996/97		762	762	31,593	8846.04	884.60	222	1106.60	344.604
8	1997/98		809	809	31,877	13388.34	1338.83	234	1572.83	763.834
9	1998/99		957	957	32,201	13524.42	1352.44	243	1595.44	638.442
10	1999/00		1,018	1,018	32,486	13644.12	1364.41	252	1616.41	598.412
11	2000/01		1,126	1,126	32,769	13762.98	1376.30	258	1634.30	508.298
12	2001/02		1,258	1,258	33,012	13865.04	1386.50	267	1653.50	395.504
13	2002/03		1,315	1,315	33,256	18623.36	3724.67	276	4000.67	2685.672
14	2003/04		1,529	1,529	33,580	18804.80	3760.96	288	4048.96	2519.96
15	2004/05		1,658	1,658	33,823	18940.88	3788.18	297	4085.18	2427.176
16	2005/06		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
17	2006/07		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
18	2007/08		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
19	2008/09		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
20	2009/10		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
21	2010/11		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
22	2011/12		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
23	2012/13		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
24	2013/14		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
25	2014/15		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
26	2015/16		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
27	2016/17		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
28	2017/18		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
29	2018/19		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
30	2019/20		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
31	2020/21		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
32	2021/22		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
33	2022/23		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
34	2023/24		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
35	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
36	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
37	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
38	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
39	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
40	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
41	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
42	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
43	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
44	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504
45	2024/25		1,848	1,848	34,067	19077.52	3815.50	300	4115.50	2267.504

Table XIV-8 Discounted Cash Flow of Project Incremental Costs and Benefits (Case 4)

CASE-4

Discounted Cash Flow of Project Incremental Costs and Benefits

B-C: -67667.73 | B/C: 0.1427280 | IRR: -0.005240

		Investment (LE1,000)	CostO&M Costs	Total	Incre.Water Consumption (1000m3)	Water Tariff Revenue	Sewerage Revenue	Non-Tariff Revenue (LE1000)	Total	
0	1989/90	15,904		15,904					0.00	-15904
1	1990/91	15,752	0	15,752					0.00	-15752
2	1991/92	25,499	332	25,831	24,699	3457.86	345.79		345.79	-25485.21
3	1992/93	25,496	362	25,858	26,402	9240.70	924.07		924.07	-24933.93
4	1993/94	18,911	390	19,301	28,024	9808.40	980.84		980.84	-18320.16
5	1994/95	18,909	489	19,398	29,687	10390.45	1039.04		1039.04	-18358.95
6	1995/96		653	653	31,350	10972.50	1097.25	213	1310.25	657.25
7	1996/97		762	762	31,593	11057.55	1105.76	222	1327.76	565.755
8	1997/98		809	809	31,877	15619.73	3123.95	234	3357.95	2548.946
9	1998/99		957	957	32,201	15778.49	3155.70	243	3398.70	2441.698
10	1999/00		1,018	1,018	32,486	15918.14	3183.63	252	3435.63	2417.628
11	2000/01		1,126	1,126	32,769	16056.81	3211.36	258	3469.36	2343.362
12	2001/02		1,258	1,258	33,012	16175.88	3235.18	267	3502.18	2244.176
13	2002/03		1,315	1,315	33,256	20951.28	4190.26	276	4466.26	3151.256
14	2003/04		1,529	1,529	33,580	21155.40	4231.08	288	4519.08	2990.08
15	2004/05		1,658	1,658	33,823	21308.49	4261.70	297	4558.70	2900.698
16	2005/06		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
17	2006/07		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
18	2007/08		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
19	2008/09		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
20	2009/10		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
21	2010/11		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
22	2011/12		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
23	2012/13		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
24	2013/14		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
25	2014/15		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
26	2015/16		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
27	2016/17		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
28	2017/18		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
29	2018/19		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
30	2019/20		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
31	2020/21		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
32	2021/22		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
33	2022/23		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
34	2023/24		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
35	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
36	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
37	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
38	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
39	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
40	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
41	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
42	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
43	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
44	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442
45	2024/25		1,848	1,848	34,067	21462.21	4292.44	300	4592.44	2744.442

CASE-5

Table XIV-9 Discounted Cash Flow of Project Incremental Costs and Benefits (Case 5)

Discounted Cash Flow of Project Incremental Costs and Benefits

B-C (58,836)

B/C 0.251540

IRR 0.023551

		Investment	CostO&M Costs	Total	Incre.Water Consumption (1000m3)	Water Tariff revenue	Sewerage Revenue	Non-Tariff Revenue (LE1000)	Total	
0	1989/90	15,904		15,904					0	(15,904)
1	1990/91	15,752	0	15,752					0	(15,752)
2	1991/92	25,499	332	25,831	24,699	3,457.86	345.79		346	(25,485)
3	1992/93	25,496	362	25,858	26,402	9,240.70	2,772.21		2,772	(23,086)
4	1993/94	18,911	362	19,273	28,024	9,808.40	2,942.52		2,943	(16,330)
5	1994/95	18,909	390	19,299	29,687	10,390.45	3,117.14		3,117	(16,182)
6	1995/96		489	489	31,350	10,972.50	3,291.75	213	3,505	3,016
7	1996/97		653	653	31,593	11,057.55	3,317.27	222	3,539	2,886
8	1997/98		762	762	31,877	15,619.73	4,685.92	234	4,920	4,158
9	1998/99		809	809	32,201	15,778.49	4,733.55	243	4,977	4,168
10	1999/00		957	957	32,486	15,918.14	4,775.44	252	5,027	4,070
11	2000/01		1,018	1,018	32,769	16,056.81	4,817.04	258	5,075	4,057
12	2001/02		1,126	1,126	33,012	16,175.88	4,852.76	267	5,120	3,994
13	2002/03		1,258	1,258	33,256	20,951.28	6,285.38	276	6,561	5,303
14	2003/04		1,315	1,315	33,580	21,155.40	6,346.62	288	6,635	5,320
15	2004/05		1,529	1,529	33,823	21,308.49	6,392.55	297	6,690	5,161
16	2005/06		1,658	1,658	34,067	21,462.21	6,438.66	300	6,739	5,081
17	2006/07		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
18	2007/08		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
19	2008/09		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
20	2009/10		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
21	2010/11		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
22	2011/12		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
23	2012/13		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
24	2013/14		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
25	2014/15		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
26	2015/16		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
27	2016/17		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
28	2017/18		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
29	2019/20		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
30	2020/21		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
31	2021/22		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
32	2022/23		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
33	2023/24		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
34	2024/25		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
35	2025/26		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
36	2026/27		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
37	2027/28		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
38	2028/29		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
39	2029/30		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
40	2030/31		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
41	2031/32		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
42	2032/33		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
43	2033/34		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
44	2034/35		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891
45	2035/26		1,848	1,848	34,067	21,462.21	6,438.66	300	6,739	4,891

Table XIV-10 Long-Run Average Incremental Cost for Sewerage Service at Market Prices

Year	Investment Cost (1,000 LE)	Operating Cost (1,000 LE)	Total Cost (1,000 LE)	Incremental Volume (1,000 m3)	Discount Rate (%) 13		15		17	
1989	18,774		18,774		18,774.00	0.00	18,774.00	0.00	18,774.00	0.00
1990	18,622		18,622		16,479.65	0.00	16,193.04	0.00	15,916.24	0.00
1991	31,065	332	31,397	16,060	24,588.46	12,577.34	23,740.64	12,143.67	22,935.93	11,732.05
1992	31,064	362	31,426	17,155	21,779.79	11,889.28	20,663.11	11,279.69	19,621.47	10,711.08
1993	22,294	390	22,684	18,980	13,912.52	11,640.79	12,969.65	10,851.88	12,105.32	10,128.68
1994	22,283	489	22,772	20,444	12,359.73	11,096.18	11,321.71	10,164.28	10,386.56	9,324.74
1995	-	653	653	22,630	313.65	10,869.61	282.31	9,783.57	254.56	8,822.05
1996	-	762	762	22,995	323.90	9,774.27	286.46	8,644.67	253.89	7,661.83
1997	-	809	809	23,360	304.31	8,787.09	264.46	7,636.43	230.39	6,652.52
1998	-	957	957	24,455	318.57	8,140.70	272.04	6,951.64	232.94	5,952.44
1999	-	1,018	1,018	25,185	299.89	7,419.21	251.63	6,225.35	211.78	5,239.42
2000	-	1,126	1,126	25,550	293.55	6,660.83	242.03	5,491.80	200.21	4,543.04
2001	-	1,258	1,258	26,280	290.23	6,062.95	235.13	4,911.92	191.18	3,993.88
2002	-	1,315	1,315	27,010	268.48	5,514.48	213.72	4,389.88	170.81	3,508.39
2003	-	1,529	1,529	27,740	276.25	5,011.97	216.09	3,920.46	169.75	3,079.67
2004	-	1,658	1,658	28,105	265.10	4,493.73	203.76	3,453.95	157.32	2,666.83
2005	-	1,848	1,848	28,835	261.49	4,080.04	197.49	3,081.45	149.87	2,338.55
2006	-	1,848	1,848	28,835	231.40	3,610.66	171.73	2,679.52	128.10	1,998.76
2007	-	1,848	1,848	28,835	204.78	3,195.27	149.33	2,330.02	109.49	1,708.34
2008	-	1,848	1,848	28,835	181.22	2,827.68	129.85	2,026.10	93.58	1,460.12
2009	-	1,848	1,848	28,835	160.37	2,502.37	112.91	1,761.83	79.98	1,247.97
2010	-	1,848	1,848	28,835	141.92	2,214.48	98.19	1,532.02	68.36	1,066.64
2011	-	1,848	1,848	28,835	125.60	1,959.72	85.38	1,332.19	58.43	911.66
2012	-	1,848	1,848	28,835	111.15	1,734.27	74.24	1,158.43	49.94	779.19
2013	-	1,848	1,848	28,835	98.36	1,534.75	64.56	1,007.33	42.68	665.98
2014	-	1,848	1,848	28,835	87.04	1,358.18	56.14	875.94	36.48	569.21
2015	-	1,848	1,848	28,835	77.03	1,201.93	48.82	761.69	31.18	486.51
2016	-	1,848	1,848	28,835	68.17	1,063.66	42.45	662.34	26.65	415.82
2017	-	1,848	1,848	28,835	60.33	941.29	36.91	575.94	22.78	355.40
2018	-	1,848	1,848	28,835	53.39	833.00	32.10	500.82	19.47	303.76
2019	-	1,848	1,848	28,835	47.24	737.17	27.91	435.50	16.64	259.62
2020	-	1,848	1,848	28,835	41.81	652.36	24.27	378.69	14.22	221.90
2021	-	1,848	1,848	28,835	37.00	577.31	21.10	329.30	12.15	189.66
2022	-	1,848	1,848	28,835	32.74	510.89	18.35	286.35	10.39	162.10
2023	-	1,848	1,848	28,835	28.98	452.12	15.96	249.00	8.88	138.55
2024	-	1,848	1,848	28,835	25.64	400.11	13.88	216.52	7.59	118.42
Total	144,102	49,618	193,720	902,649	112,924	152,326	107,551	128,030	102,799	109,415
Average Cost (LE/m3)					0.74		0.84		0.94	

Table XIV-11 Long-Run Average Incremental Cost for Sewerage Service at Economic Prices

Year	Capital Cost(*.7) (1,000 LE)	Operating Cost(*.7) (1,000 LE)	Total Cost (1,000 LE)	Incremental Volume (1,000 m3)	Discount Rate (%) 13		15		17	
1989	13,142		13,142		13,141.80	0.00	13,141.80	0.00	13,141.80	0.00
1990	13,035		13,035		11,535.75	0.00	11,335.13	0.00	11,141.37	0.00
1991	21,746	232	21,978	16,060	17,211.92	12,577.34	16,618.45	12,143.67	16,055.15	11,732.05
1992	21,745	253	21,998	17,155	15,245.86	11,889.28	14,464.17	11,279.69	13,735.03	10,711.08
1993	15,606	273	15,879	18,980	9,738.77	11,640.79	9,078.76	10,851.88	8,473.72	10,128.68
1994	15,598	342	15,940	20,444	8,651.81	11,096.18	7,925.20	10,164.28	7,270.59	9,324.74
1995	-	457	457	22,630	219.55	10,869.61	197.62	9,783.57	178.20	8,822.05
1996	-	533	533	22,995	226.73	9,774.27	200.52	8,644.67	177.73	7,661.83
1997	-	566	566	23,360	213.02	8,787.09	185.12	7,636.43	161.27	6,652.52
1998	-	670	670	24,455	223.00	8,140.70	190.43	6,951.64	163.06	5,952.44
1999	-	713	713	25,185	209.92	7,419.21	176.14	6,225.35	148.25	5,239.42
2000	-	788	788	25,550	205.48	6,660.83	169.42	5,491.80	140.15	4,543.04
2001	-	881	881	26,280	203.16	6,062.95	164.59	4,911.92	133.83	3,993.88
2002	-	921	921	27,010	187.93	5,514.48	149.61	4,389.88	119.57	3,508.39
2003	-	1,070	1,070	27,740	193.38	5,011.97	151.26	3,920.46	118.82	3,079.67
2004	-	1,161	1,161	28,105	185.57	4,493.73	142.63	3,453.95	110.13	2,666.83
2005	-	1,294	1,294	28,835	183.04	4,080.04	138.24	3,081.45	104.91	2,338.55
2006	-	1,294	1,294	28,835	161.98	3,610.66	120.21	2,679.52	89.67	1,998.76
2007	-	1,294	1,294	28,835	143.35	3,195.27	104.53	2,330.02	76.64	1,708.34
2008	-	1,294	1,294	28,835	126.86	2,827.68	90.90	2,026.10	65.50	1,460.12
2009	-	1,294	1,294	28,835	112.26	2,502.37	79.04	1,761.83	55.99	1,247.97
2010	-	1,294	1,294	28,835	99.35	2,214.48	68.73	1,532.02	47.85	1,066.64
2011	-	1,294	1,294	28,835	87.92	1,959.72	59.77	1,332.19	40.90	911.66
2012	-	1,294	1,294	28,835	77.80	1,734.27	51.97	1,158.43	34.96	779.19
2013	-	1,294	1,294	28,835	68.85	1,534.75	45.19	1,007.33	29.88	665.98
2014	-	1,294	1,294	28,835	60.93	1,358.18	39.30	875.94	25.54	569.21
2015	-	1,294	1,294	28,835	53.92	1,201.93	34.17	761.69	21.83	486.51
2016	-	1,294	1,294	28,835	47.72	1,063.66	29.71	662.34	18.65	415.82
2017	-	1,294	1,294	28,835	42.23	941.29	25.84	575.94	15.94	355.40
2018	-	1,294	1,294	28,835	37.37	833.00	22.47	500.82	13.63	303.76
2019	-	1,294	1,294	28,835	33.07	737.17	19.54	435.50	11.65	259.62
2020	-	1,294	1,294	28,835	29.27	652.36	16.99	378.69	9.95	221.90
2021	-	1,294	1,294	28,835	25.90	577.31	14.77	329.30	8.51	189.66
2022	-	1,294	1,294	28,835	22.92	510.89	12.85	286.35	7.27	162.10
2023	-	1,294	1,294	28,835	20.28	452.12	11.17	249.00	6.22	138.55
2024	-	1,294	1,294	28,835	17.95	400.11	9.71	216.52	5.31	118.42
Total	100,871	34,733	135,604	902,649	79,047	152,326	75,286	128,030	71,959	109,415
Average Cost		(LE/m3)			0.52		0.59		0.66	

APPENDIX - XV

STUDY ON BAHR EL BAKAR DRAIN

APPENDIX - XV

STUDY ON BAHR EL BAKAR DRAIN

Table of Contents

List of Tables

List of Figures

1. Study on Bahr El Bakar Drain

Bahr El Bakar Drain starts at the confluence of the Kalubia El Raisi and Bilbeis El Bahari Drains. Bahr El Bakar Drain is 97 km long and discharges into Lake Manzala at the El Genki area, the most southern part of the Lake. A map illustrating the location of Bahr El Bakar Drain is shown in Figure XV-1.

According to the report "Lake Manzala Study" prepared by Maclaren Engineers, Planners & Scientists Inc. in 1982, the physical characteristics of Bahr El Bakar Drain are shown in Table XV-1. As the drain widens and deepens in the downstream direction the water surface and bottom slopes decrease. The annual contribution of Bahr El Bakar Drain to Lake Manzala is said to be about 678 x 10^6 m^3/year. Of this total, approximately 300 x 10^6 m^3/year is sewage discharged from Cairo via Bilbeis El Bahari Drain. This relatively constant flow of Cairo Sewage may contribute to the low variation in the recorded monthly flows. Table XV-2 shows Flow Record of Bahr El Bakar Drain during the period of 1974 to 1978.

As identified by JICA Team in 1988, the water quality of Bahr El Bakar Drain is most significantly affected by the input of Cairo sewage (see Appendix IV). Table XV-3 shows the water quality profile along the Bahr El Bakar Drain from upstream of Gabal Asafar Drain in Cairo to Faqus in Sharqiya.

Some reduction in nutrient and BOD levels can be observed along the length of the drain. This is most likely due to dilution effect from agricultural drainage and the presence of facultative organisms in the drain.

Table XV-1 Physical Characteristics of Bahr El Bakar Drain

Characteristic	Headwaters	Near the Outlet
Bottom Width	17 m	160 m
Bottom Slope	9 cm/km	2 cm/km
Water Depth	3.76 m	4.95 m
Water Surface Slope	8 cm/km	1.5 cm/km

Source : Ministry of Irrigation

Table XV-2 Flow Records of Bahr El Bakar Drain

	Year					
Month	1974	1975	1986	1977	1978	Average
January	111.600	137.836	127.162	151.632	130.076	131.639
February	60.128	124.432	119.500	92.222	106.700	100.596
March	134.854	120.776	127.176	126.976	142.976	130.552
April	148.080	129.156	125.264	116.304	154.380	134.637
May	139.681	165.664	124.616	130.076	149.099	141.827
June	134.880	142.080	120.080	102.726	145.650	129.083
July	149.806	132.020	118.976	111.996	164.176	135.395
August	161.014	148.676	135.876	173.476	164.176	156.644
September	162.336	158.952	150.530	167.104	158.880	159.560
October	157.976	153.352	138.486	157.300	162.750	153.973
November	175.376	137.880	134.580	145.176	155.880	149.778
December	184.284	172.372	135.538	148.535	130.975	154.347
Year Total	1719.995	1723.186	1557.84	1623.573	1765.718	1678.051

Notes :
1. Flows in $m^3 \times 10^6$ per month

2. Source : Ministry of Irrigation Records

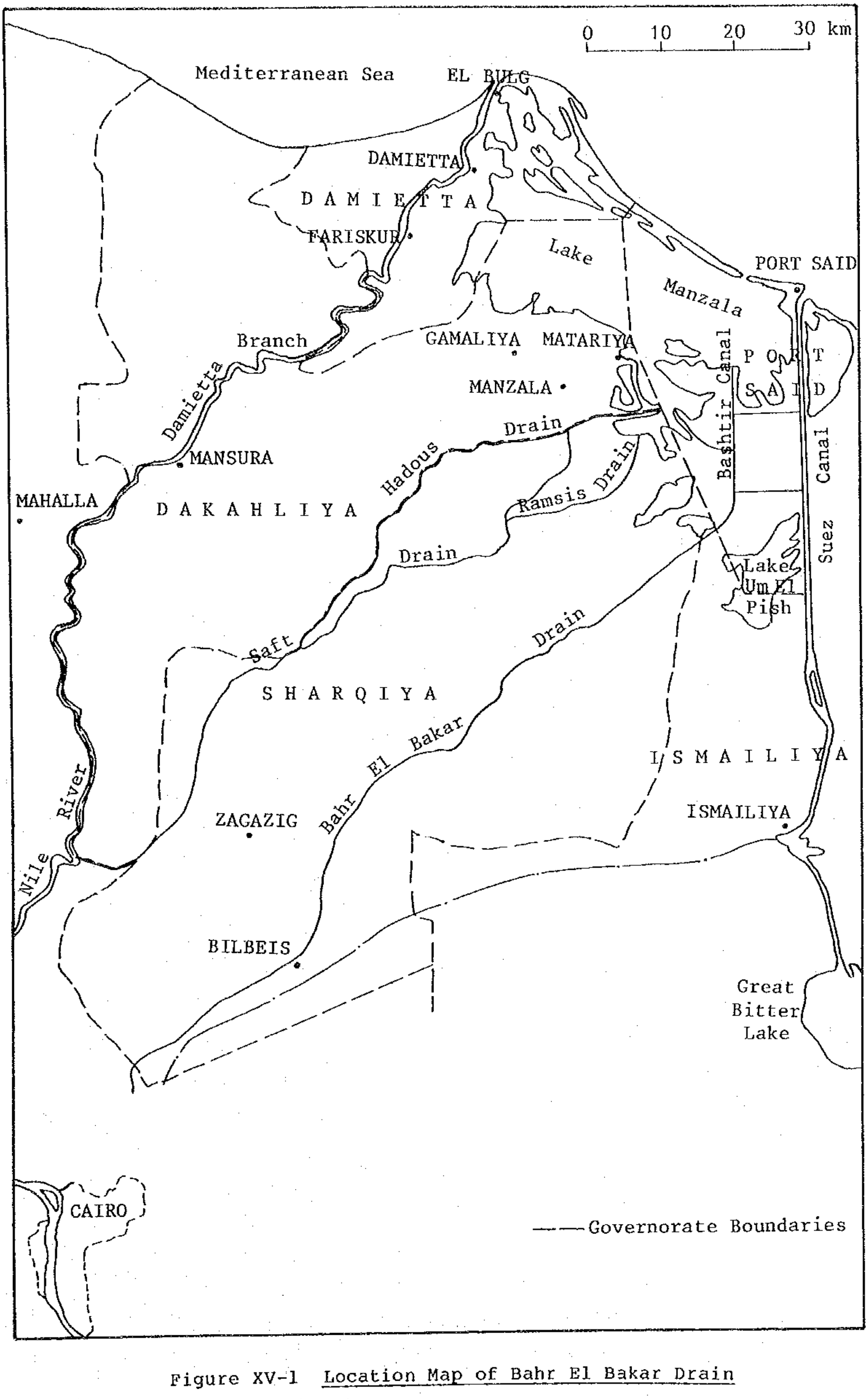


Figure XV-1 Location Map of Bahr El Bakar Drain

Table XV-3 Water Quality Profile along Bahr El Bakar Drain

Parameter	Upstream Gabal Asafar Drain	Gabal Asafar Drain	Downstream Gabal Asafar Drain	Bahr El Bakar Upstream Kalubia Drain	Kalubia Drain	Bahr El Bakar Downstream Kalubia Drain	Faqus	500 m Upstream Bahr El Bakar	Bahr El Bakar P.S.	500 m Downstream Bahr El Bakar
pH	7.3	7.6	7.7	7.8	7.8	7.8	8.2	7.6	7.8	7.6
Turbidity NTU	70	150	100	30	15	22	12	10	15	10
DO	Nil	Nil	Nil	Nil	1.6	Nil	Nil	Nil	4.5	Nil
BOD	195	345	270	48	96	96	60	54	60	84
Total Suspended Solids at 105°C (mg/l)	77	183	205	58	19	51.5	52	17.5	31	18.5
Inorganic Suspended Solids at 550°C (mg/l)	14	53	69	32	6.5	22	37.5	11.5	18.5	11
Volatile Suspended Solids at 550°C (mg/l)	63	130	136	26	12.5	29.5	14.5	6	12.5	7.5
Dissolved Salts at 105°C (mg/l)	1008	780	813	582	447	612	570	642	1250	655
Inorganic Salts at 550°C (mg/l)	783	637	618	494	334	453	426	468	783	549
Volatile Salts at 550°C (mg/l)	225	143	195	88	163	159	144	174	533	106
Chloride (mg/l)	240	250	260	160	200	160	160	180	1020	220
Total Alkalinity (mg/l)	440	500	340	500	320	360	340	380	360	360
Total Phosphate (g/l)	1960	4900	3430	1630	490	1630	1030	1030	217	1030
Dissolved Phosphate (g/l)	816	2830	1680	1307	326	1190	816	925	traces	760
Nitrite (mg/l)	.06	.06	.06	0.025	0.025	.015	traces	traces	.047	traces
Nitrate (mg/l)	.055	.055	.056	0.09	0.4	0.2	0.25	.33	.57	0.48
Ammonia (mg/l)	20.72	16.24	15.68	7.84	0.84	7.84	5.88	4.20	Nil	5.04
Total Organic Nitrogen(mg/l-N)	21.0	27.3	26.00	11.06	1.96	10.36	7.0	6.58	1.26	6.20

Source : Water Pollution Control Labortory, National Centre, Lake Nasser and River Nile Water Quality Studies

APPENDIX - XVI

RESULTS OF SOCIO-ECONOMIC SURVEY

APPENDIX - XVI

RESULTS OF SOCIO-ECONOMIC SURVEY

Table of Contents

List of Figures

1. Introduction

The income level of the consumers has a significant impact upon the pricing policy for sewerage service. Hence, to evaluate the general income level of the Project area, a household income survey was designed and implemented in close cooperation with the economist counterpart, Mr. Nabil Ebrahim Hassan. A mother sample of about one hundered sixty (160) families was randomly selected with due attention to even distribution among income classes such as high-income, middle-income and low-income groups from the four priority cities i.e., Zagazig, Faqus, Minyet El Qamh and Bilbeis plus Abu Kebir. The location of the household families sampled during the survey are shown on Figures XVI-1 through XVI-5. The questionnaire format attached herewith was prepared and the data were collected by direct interview method. The following is the outcome (raw data) of the survey.

2. <u>Questionnaire on Wastewater Consumer</u>

(1) Household Information

a. Number of Household Members: .... __________________

b.. Age of Household Head: .... __________________

c. Occupation of Household Head: .... __________________

d. Average Monthly Salary: .... LE __________________

(2) Water Supply and Wastewater Consumption Information

a. Do you have water supply/sewerage connection? Yes / No

a-1. If yes, Average Monthly Payment .... LE __________________

a-2. If no, do you rent vacuum car regularly? Yes / No

a-2-1. If yes, how often rent yearly? times/year

a-2-2. How much do you pay (or share) one time? .. LE __________________

a-2-3. If no, how do you do with wastewater? __________________

____

Name of Markaz __________________

Household No. __________________

Interviewed by __________________

Feb. 1988

3. The Results of Questionnaire Survey

	Age	No	Income	Month/Rate	Connc. Wat.	Connc. Sew.	Times	Rent
Zagazig								
1	45	5	400	0.7	Y	Y	-	-
2	45	4	500	1.0-1.5	Y	Y	-	-
3	54	5	500	1.5-2.5	Y	Y	-	-
4	60	2	200	1.0	Y	Y	-	-
5	57	6	300	0.5-1.0	Y	Y	-	-
6	55	3	400	1.3	Y	Y	-	-
7	42	8	150	1.0	Y	Y	-	-
7-1	38	5	300	2.0-2.5	Y	Y	-	-
8	60	7	500	4.0	Y	Y	-	-
9	37	4	130	0.7	Y	Y	-	-
10	38	5	400	1.5	Y	Y	-	-
11	42	2	250	1.5	Y	Y	-	-
12	55	6	200	3.0	Y	Y	-	-
13	30	4	500	2.0	Y	Y	-	-
14	58	5	400	1.0-1.2	Y	Y	-	-
15	30	4	40	0.6	Y	Y	-	-
16	52	5	250	3.0	Y	Y	-	-
17	60	5	200	1.5	Y	Y	-	-
18	53	8	300	2.0	Y	Y	-	-
19	58	10	100	2.0	Y	Y	-	-
20	28	5	200	1.0	Y	Y	-	-
21	45	4	160	0.4	Y	Y	-	-
22	38	2	80	1.0	Y	Y	-	-
23	75	1	33	0.3	Y	Y	-	-
24	39	8	210	1.0	Y	NO	1/2-3yrs	1.0(0.04)
25	74	13	130	3.0	Y	Y	-	-
26	40	5	300	1.5	Y	Y	-	-
27	30	3	100	0.8	Y	Y	-	-
28	40	4	200	0.8-1.0	Y	Y	-	-
29	60	4	100	1.8	Y	Y	-	-
30	45	4	100	0.25	Y	Y	1/2yrs	8.0(0.4)
31	82	6	40	1.5	Y	NO	1/2yrs	8.0(0.4)
32	50	6	200	2.0	Y	Y	-	-
33	42	4	68	2.0-3.0	Y	Y	-	-

Minyet El Qamh

34	35	5	57	1.7	Y	NO	EvryMonth	4.0
35	43	6	75	1.7	Y	NO	4/yr	4.0(1.4)
36	35	5	80	1.5	Y	NO	4/yr	4.0(1.4)
37	38	4	120	0.8	Y	NO	EvryMonth	1.0
38	45	6	200	1.4	Y	NO	1/yr	4.8(0.4)
39	37	5	100	1.4	Y	NO	None/5yrs	-
40	31	2	145	0.7	Y	NO	EvryMonth	1.0
41*1	63	9	150	3.0	Y	NO	None/15yrs	-
42*2	30	3	100	11.6	Y	NO	Evry2days	1.0(15.0)
43	30	4	105	1.0	Y	NO	None/10yrs	-
44	45	6	80	1.4	Y	NO	None/10yrs	-
45	28	15	200	2.0	Y	NO	None/12yrs	-
46	42	3	500	1.5	Y	NO	None/7yrs	-
47	65	3	200	0.5	Y	NO	None/12yrs	-
48	55	8	158	0.5	Y	Y	-	-
49	65	6	210	0.75	Y	Y	-	-
50	45	7	2,000	2.0	Y	Y	-	-
51	65	3	42	2.0	Y	Y	-	-
52	52	5	170	0.9	Y	Y	-	-
53	33	7	300	0.5	Y	Y	-	-
54	55	6	150	0.8	Y	Y	-	-
55	51	4	130	0.75	Y	Y	-	-
56	30	5	150	0.7	Y	Y	-	-
57	63	6	150	1.7	Y	Y	-	-
58	40	7	70	1.0	Y	NO	1/yr	0.65(0.06)
59	45	7	150	1.7	Y	Y	-	-
60	40	4	200	1.7	Y	Y	-	-
61	57	7	155	1.5	Y	NO	1/2-3yrs	4.0(0.17)
62	43	6	50	1.0	Y	NO	None/20yrs	-
63	67	8	45	0.5	Y	Y	-	-

*1: Sewerage is discharged directly to the drain.

*2: A factory is located at the first floor and thus sewerage transfer is necessary every two days.

Bilbeis

64	51	3	400	1.0	Y	Y	-	-
65	42	4	600	0.25	Y	Y	-	-
66	52	4	200	0.3	Y	Y	-	-
67	45	7	95	0.5	Y	Y	-	-
68	35	6	120	0.8	Y	NO	2/yrs	0.8(0.14)
69	40	7	60	0.5	Y	Y	-	-
70	35	5	150	1.4	Y	Y	-	-
71	31	4	150	0.4	Y	NO	Monthly	4.0
72	60	3	70	0.75	Y	NO	Evry3month	1.7(0.57)
73	60	7	90	0.5	Y	NO	Evry20day	3.0(4.5)
74	40	7	190	0.9	Y	NO	Monthly	5.0
75	40	7	200	0.4	Y	NO	Monthly	3.4
76	52	7	170	0.3	Y	Y	-	-
77	45	8	150	0.75	Y	Y	-	-
78	32	5	200	1.0	Y	Y	-	-
79	26	3	140	0.5	Y	Y	-	-
80*3	50	3	50	None	NO	NO	None	None
81*3	60	2	60	None	NO	NO	None	None
82*3	50	17	150	None	NO	Y	None	None
83	47	6	120	0.8	Y	Y	-	-
84	39	5	60	None	NO	NO	None	None
85	65	10	2,000	1.0	Y	Y	-	-
86	60	8	60	0.7	Y	Y	-	-
87	38	4	80	0.3	Y	Y	-	-
88	65	6	120	0.8	Y	Y	-	-
89*4	28	2	100	1.75	Y	Y	-	-
90	65	9	80	0.75	Y	Y	-	-
91	65	6	50	None	NO	NO	EvryYear	0.9(0.08)
92	50	7	150	None	NO	Y	-	None
93	31	6	300	None	NO	NO	1/2months	3.0(1.5)
94	45	3	100	0.35	Y	NO	EvryYear	10.0(0.8)
95	45	7	150	0.75	Y	Y	-	-
96	65	4	80	0.6	Y	Y	-	-
97	35	9	70	0.7	Y	NO	1/1-2yrs	7.0(0.3)
98*5	40	6	150	0.75	Y	NO	Evry2day	by Markaz
99	57	7	300	0.35	Y	NO	1/2yrs	7.0(0.3)
100	42	7	300	1.0	Y	NO	-	-
101	45	9	100	0.4	Y	NO	Monthly	3.0

*3: The house has no sewerage connection, but has transh, and its effluent leaks into soil and vacuum car has never been rent.

*4: The owner is said to wash his car quite often.

*5: The consumers who lives in a public apartment built by Markaz are free from sewerage charges and Markaz pays.

Abu Kebir

102	61	11	500	3.0	Y	Y	–	–
103	34	4	200	3.0	Y	Y	–	–
104	60	5	150	1.25	Y	Y	–	–
105	54	7	200	4.0	Y	Y	–	–
106	65	7	200	3.4	Y	Y	–	–
107	65	3	150	1.5	Y	Y	–	–
108	38	5	200	2.0	Y	NO	None/4yrs	–
109	39	10	150	0.5	Y	Y	–	–
110	55	7	300	1.0	Y	Y	–	–
111	32	5	100	0.7	Y	Y	–	–
112	65	2	32	None	NO	NO	None	None
113	65	12	700	7.5	Y	Y	–	–
114	45	4	60	0.7	Y	Y	–	–
115*6	38	4	300	1.0	Y	Y	–	7.0(0.6)
116*6	36	5	250	1.0	Y	Y	–	7.0(0.6)
117	42	3	50	0.4	Y	Y	–	–
118	45	4	240	0.4	Y	Y	–	2.0(0.2)
119	30	7	100	1.4	Y	NO	None	None
120	60	4	70	0.5	Y	NO	1/3-4months	1.5(0.5)
121	46	7	200	0.5	Y	NO	1/8months	5.0(0.6)
122	38	7	200	1.4	Y	NO	Weekly	8.0(32.0)
123	45	6	300	0.7	Y	NO	1/10days	3.0(9.0)
124	35	2	20	0.4	Y	NO	None	None
125	30	8	100	0.8	Y	NO	Yearly	3.0(0.25)
126	28	7	150	0.8	Y	NO	1/10days	2.0(6.0)
127	70	7	70	1.0	Y	NO	1/2yrs	5.0(0.2)
128	48	8	300	0.9	Y	NO	1/3months	5.0(1.7)
129*7	45	7	100	0.75	Y	Y	–	–
130	50	8	60	1.7	Y	Y	–	–
131	45	7	70	2.75	Y	Y	–	7.0(0.6)
132*7	27	8	60	2.5	Y	Y	–	–

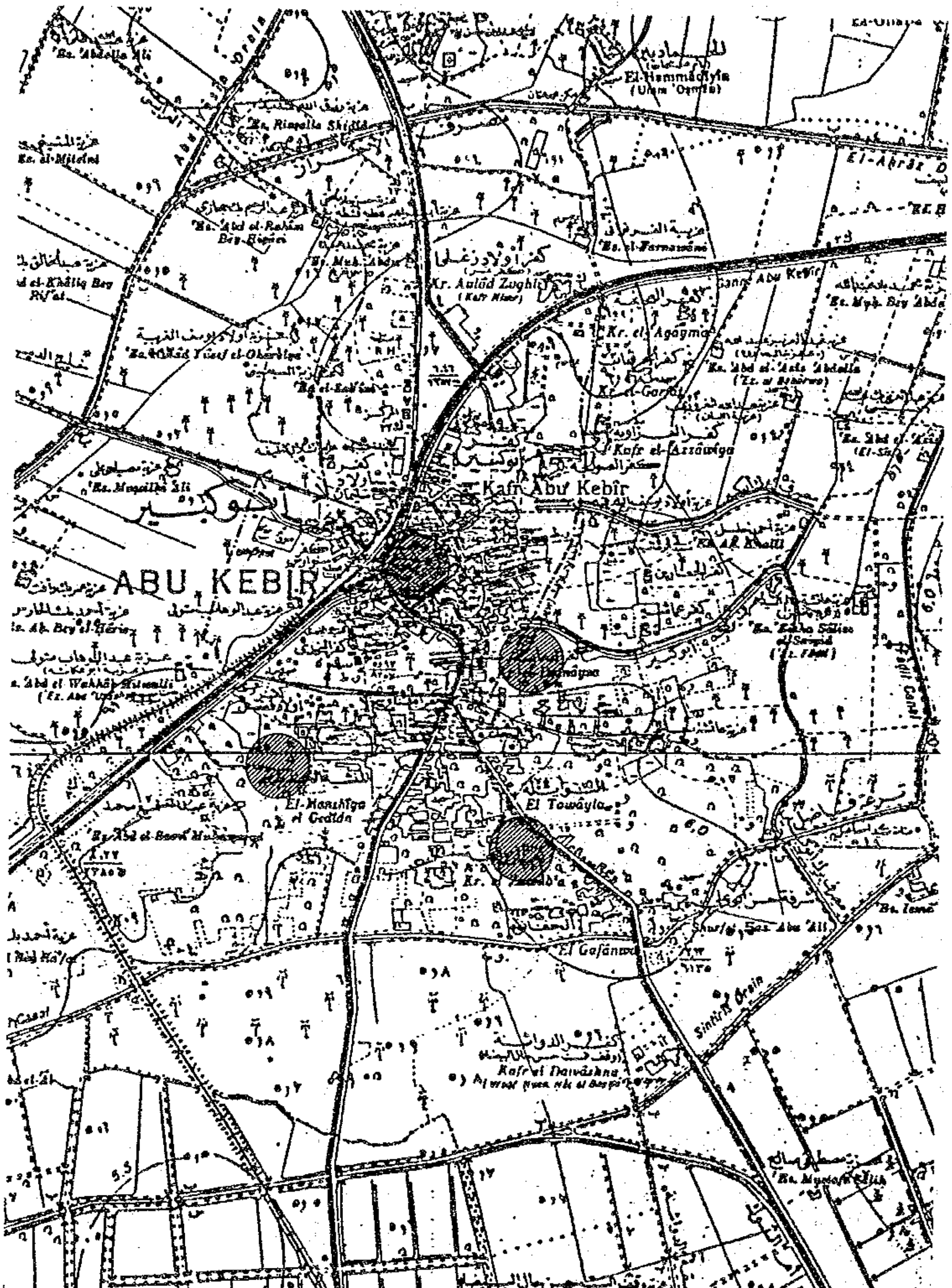
*6: The consumers paid sewerage charges separately from 10 percent surcharge of water bills.

*7: For sewerage house connection the consumer paid extra pipe installation cost for main line as well as sub-line (EL 35.0-40.0).

Faqus

133	48	3	150	0.5	Y	NO	Daily	3.9
134	68	6	540	1.5	Y	NO	None	None
135	40	7	100	0.8	Y	NO	None	None
136	35	3	200	2.1	Y	NO	None	None
137	42	5	300	1.5	Y	NO	Monthly	4.0
138	58	6	500	1.3	Y	NO	None	None
139	67	6	150	0.9	Y	NO	Daily	10.5
140	32	6	200	0.85	Y	NO	1/15days	10.5
141	29	3	150	1.2	Y	NO	Daily	10.5
142	60	7	1,000	1.0	Y	NO	Weekly	2.5(10.0)
143	26	12	250	0.7	Y	NO	Daily	1.0(30.0)
144	38	5	100	1.5	Y	NO	Weekly	1.0(4.0)
145*8	50	4	150	3.0	Y	NO	1/7months	40.0(5.7)
146	61	4	300	1.0	Y	Y	-	-
147	53	5	200	0.7	Y	NO	None	None
148	48	6	150	0.3	Y	Y	-	-
149	48	2	140	1.5	Y	Y	-	-
150	38	4	180	0.75	Y	NO	None	None
151	36	5	500	1.0	Y	Y	-	-
152	56	6	600	0.1	Y	Y	-	-
153	40	5	170	1.0	Y	Y	-	-
154	54	11	100	0.77	Y	NO	Monthly	1.4
155	50	5	100	1.2	Y	Y	-	-
156	39	8	170	0.4	Y	Y	-	-
157*8	70	3	40	1.41	Y	NO	Monthly	20.0
158	50	6	150	1.7	Y	NO	Evry3month	1.4(0.5)
159	50	5	200	1.5	Y	NO	None	None
160*8	60	5	60	0.4	Y	NO	Weekly	2.5(10.0)
161	66	5	100	0.6	Y	NO	Evrymonth	2.2
162	35	8	150	0.6	Y	NO	None	None
163*8	40	4	100	1.0	Y	NO	1/4yrs	10.0(0.2)

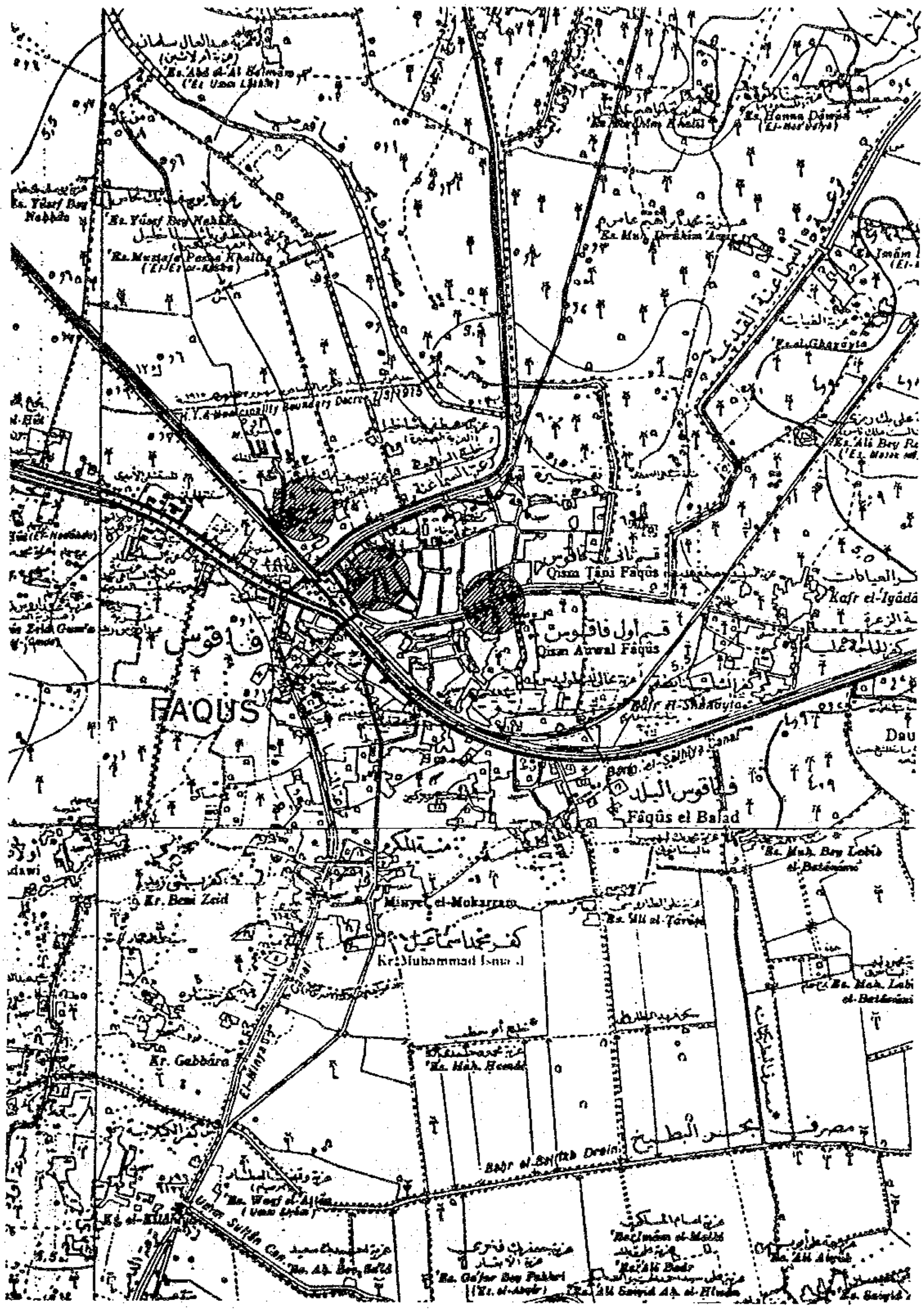
*8: The private sewerage collectors are hired due to transh location in the house. The private collector is, in fact, more expensive than the public one.



Legend

Survey Area

Figure XVI-1 Locations of Sampled and Interviewed Households, Abu Kebir City



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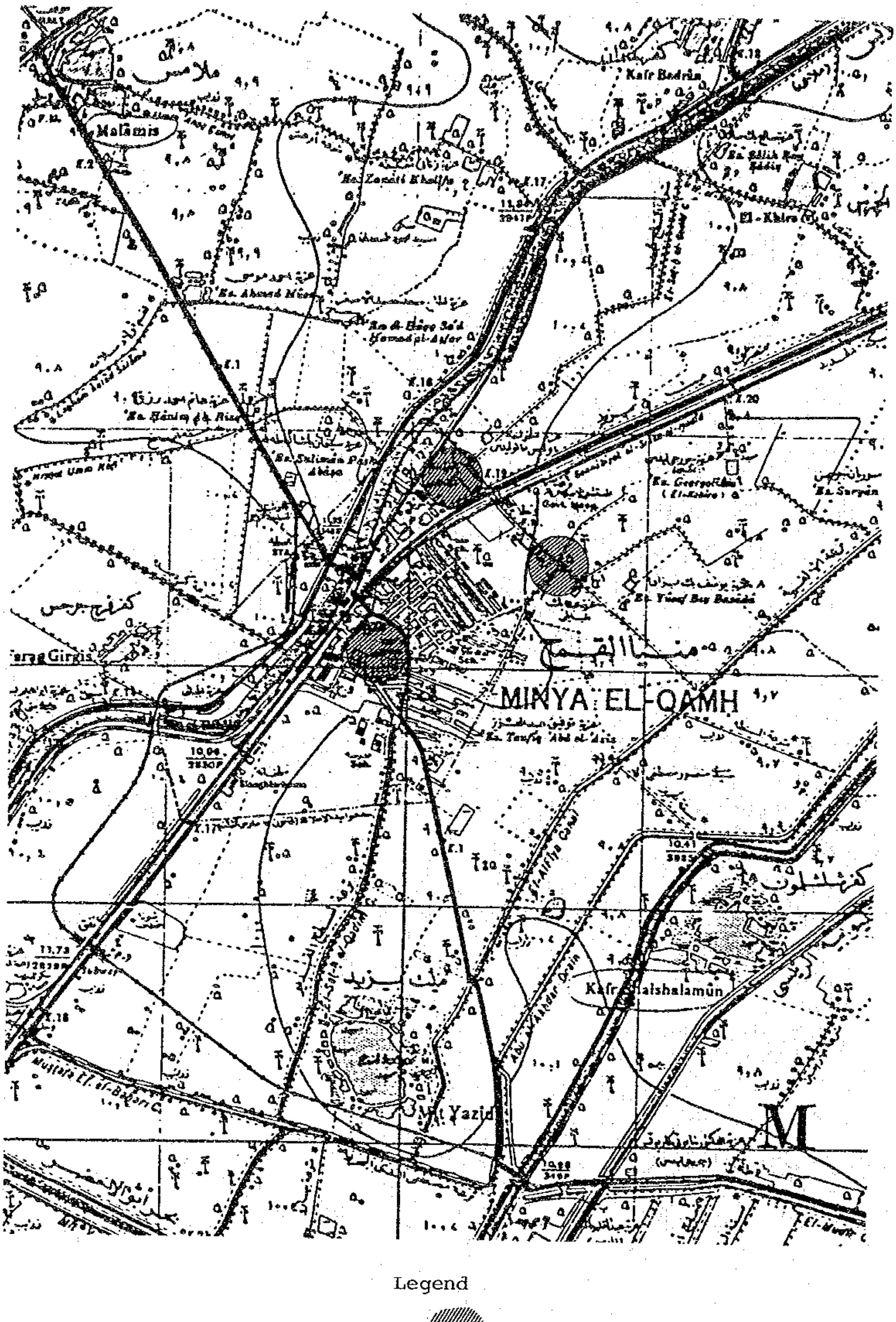
Survey Area

Figure XVI-2 Locations of Sampled and Interviewed Households, Faqus City



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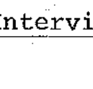
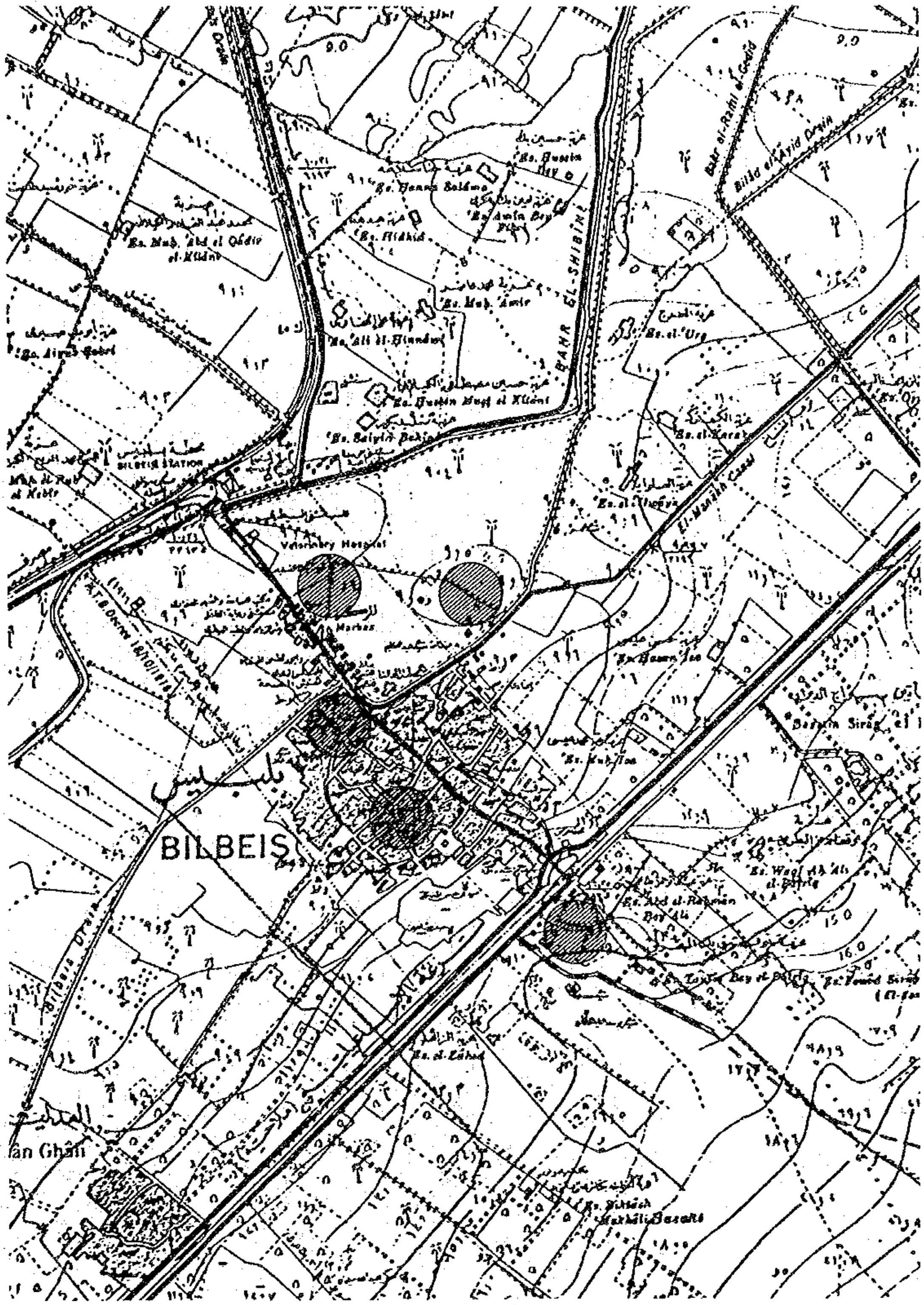
 Survey Area

Figure XVI-3 Locations of Sampled and Interviewed Households, Minyet El Qamh City



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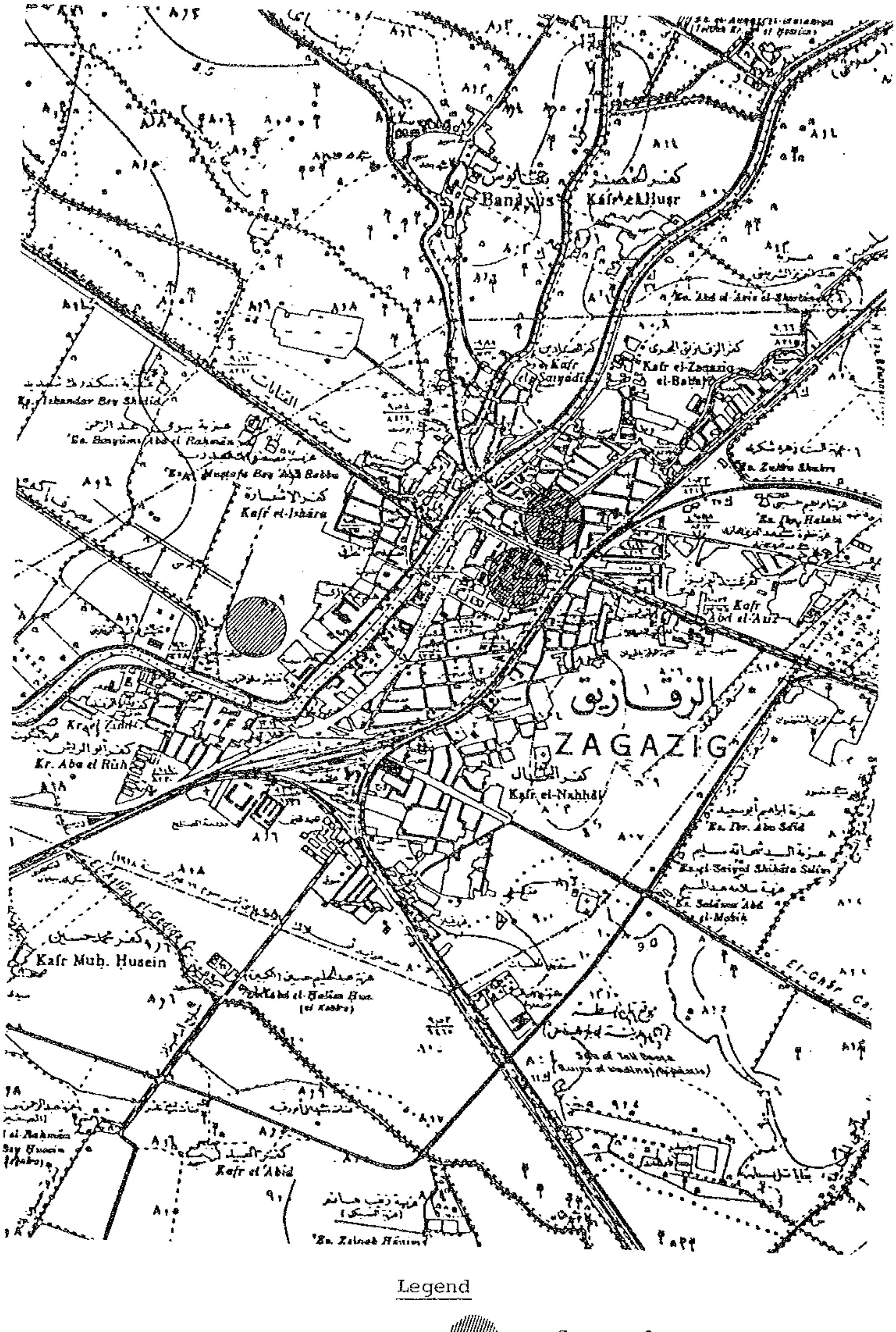
Survey Area

Figure XVI-4 Locations of Sampled and Interviewed Households, Bilbeis City



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Survey Area

Figure XVI-5 Locations of Sampled and Interviewed Households, Zagazig City

APPENDIX - XVII

SEWERAGE CHARGE REVENUES SURVEY

APPENDIX - XVII

SEWERAGE CHARGE REVENUES SURVEY

Table of Contents

List of Tables

1. Introduction

In order to review financial status of the sewerage sector, a field survey was carried out with the financial sections of the Markaz offices in the Project area concerning sources of sewerage revenue i.e., 1) sewerage tariff, 2) collection system, 3) tariff revenue, 4) sewerage connection revenue, and 5) vacuum car rental revenue. The markaz offices that were visited are: Bilbeis, Abu Kebir, Faqus, Zagazig, and Minyet El Qamh. During the survey, Mr. Nabil Ebrahim Hassan, economist, assisted us considerably in necessary data collection. The results of the field survey are summarized in the following section.

2. Results of Survey

2.1 Bilbeis

2.1.1 Source of Sewerage Revenues

For Bilbeis, sewerage revenues consist of 1) 10.0% of water use bills, 2) sewerage pipeline connection charges and 3) vacuum car rental revenues.

2.1.2 Sewerage Charge

(a) Sewerage Tariff

Sewerage charge collection started offcially from May 1985 as 10.0% of water supply bill. This Markaz had collected LE 0.04 per house for sewerage service before 1985.

The present tariff rates are those which were modified in January 1988.

(b) Collection System

Meter reading (water supply) is carried out monthly by four staff and another four staff personnel with invoice collect charges every month. If the consumer does not pay the charge on the due date, a penalty fine is imposed. Delay penalty at this Markaz is LE 0.15 levied for one month delay and LE 0.45 for more than one month. Majority of consumers pay the charges regularly, and those who delay due payment are a few and their average delayed period is 3-6 months. Public tap is free of charge.

For meter check, a serious problem is faulty meters caused by sedimentation in the line. Spare-parts are not readily available and therefore about 60.0% of the meters are faulty or malfunctioning. In case of a faulty meter, the amount of 15m^3 per house (LE 0.75) is applied automatically for water consumption, and sewerage charges follow accordingly.

(c) Tariff Revenue

The tariff revenues of 10.0% of water surcharge are as follows:

1983/84	1984/85	1985/86	1986/87
LE 845.0	4,712.2	6,392.1	6,433.0

2.1.3 Sewerage Connection Revenue

Sewerage connection works have been carried out either by Markaz office engineers or private local contractors. House connection is, at any rate, at the expense of house-owners. Usually, in case of execution by the Markaz, the house-owner requests the Markaz to install sewerage pipeline to the house. The engineers assigned by the Markaz will then survey the house location and the main pipeline location and draw up an engineering design. The house-owner is to bear the costs of survey, design, pipe and workers during installation. It is estimated that the average total costs of sewerage connection per house would amount to LE 70.0 - 80.0. For the last four years, the revenues of connection
charges for Bilbeis are as follows:

1983/84	1984/85	1985/86	1986/87
LE 9,910	7,822	7,117	4,468

2.1.4 Vacuum Car Rental Revenues

Bilbeis has five vacuum cars (3m^3, 5m^3, 6m^3, and 8m^3). A house which has no sewerage pipe connected and has a transh requests Markaz for a vacuum car. Here, there are two types of transh used in Markaz i.e., tank type and bottomless tank type. Obviously, tank-type transh requires regular transfer of sewerage. Because of low groundwater table level bottomless tank is more popular in this Markaz.

The revenues of vacuum car rental are shown in the following:

	1983/84	1984/85	1985/86	1986/87
LE	4,700	4,270	4,921	6,916

2.2 Abu Kebir

2.2.1 Source of Sewerage Revenues

Abu Kebir has three sources of revenues. They are 1) water supply surcharge, 2) flat sewerage charge and 3) vacuum car rental. There is no connection revenue in this Markaz as house connections are on a self-effort basis and therefore, no payment is made to Markaz.

2.2.2 Sewerage Charge

(a) Sewerage Tariff

Abu Kebir follows new tariff rate of January 1, 1988. Before 1985 a flat rate of LE 0.5 was levied to each house as sewerage charge.

(b) Collection System

In this Markaz, bill collection is undertaken every three months. Collection officials are three (one is for offices, the other for residential users and the third is now on leave). The penalty for delayed payment is LE 0.05 up to the first 3 days, LE 0.10 up to 5 days and LE 0.25 for more than 5 days. The average period of delay is 6 months. The Markaz has six staff for meter reading and meter check is carried out every three months. A house without water supply connection, but with sewerage connection is levied LE 2.0 per year at a flat rate. There are no public taps in this Markaz. In case of faulty meter, charges are calculated as an average over the previous three months.

(c) Tariff Revenue

The 10.0% surcharge revenues of water bill for Abu Kebir are given below:

	1985/86	1986/87	1987/88
LE	4,269.3	3,826.0	2,965.4 (as of Jan. 1988)

2.2.3 Flat Sewerage Charge

In addition to 10.0% surcharge on water consumption fees, Abu Kebir collects LE 2.0 per house as a flat sewerage charge. This has just started in 1988.

2.2.4 Vacuum Car Rental

There are five vacuum cars in this Markaz. They are four 2m^3 and one 3m^3 vacuum car. However, out of the five, three cars are in use. The revenues of vacuum car rental are as follows:

1983/84	1984/85	1985/86	1986/87
LE 2,310	2,445	2,921	2,677

2.3 Faqus

2.3.1 Source of Sewerage Revenues

Faqus has only two sources of revenues for sewerage service, namely 1) 10.0% water surcharge and 2) vacuum car rental.

2.3.2 Sewerage Charge

(a) Sewerage Tariff

The Markaz started collection of sewerage charge from July 1985. As the sewerage service has not a long history in this Markaz, there was no fee before 1985 and house connection charges have not been collected yet. The present tariff rate is the one revised in January 1988.

(b) Collection System

There are eight officers who visit the consumers every three months to collect bills. Meter readings, on the other hand, are done every month by six officers. Penalty for delayed payment is set as follows: no penalty up to 25 days, LE 0.15 between 26-30 days and LE 0.35 for more than 31 days. Public taps do not exist in this Markaz. For faulty meters, the average of latest three months bill is applied.

(c) Tariff Revenue

The 10.0% water surcharge revenues in this Markaz are included in vacuum car rental revenues.

2.3.3 Vacuum Car Rental

The Markaz owns 23 cars consisting of $3m^3$ (16 cars), $4m^3$ (2), $6m^3$ (4), and $7m^3$ (1). The household pays rental fees by coupon. This coupon system is unique in Faqus. Each coupon costs LE 0.35 and stamp fee is also charged at LE 0.35. Usually, the family needs four coupon (LE 0.35 x 4 + 0.35 = 1.75) on an average for each transfer.

The revenues of vacuum car rental and 10.0% water surcharge are shown as follows:

1983/84	1984/85	1985/86	1986/87
LE 8,300	10,202	12,558	14,378

(Note: Data given above have no breakdown by category)

2.4 Zagazig

2.4.1 Source of Sewerage Revenues

Zagazig has revenue sources of 1) 10% water surcharge, 2) pipe connection charges and 3)vacuum car rental.

2.4.2 Sewerage Charge

(a) Sewerage Tariff

Tariff rate is same as in other Marakaz and present rate structure is the one recently revised.

(b) Collection System

The collection system in Zagazig is different administratively from other Marakaz. Zagazig is divided into two districts, 1st and 2nd district and each district is further broken down into divisions. The 1st district has 11 divisions, while the 2nd district 14 divisions. There are eight collection officers for the 1st district and seven officers for the 2nd district. These collection officers are located at Markaz "mini-offices" throughout Zagazig city and they collect charges from consumers on a monthly basis. Meter readings are also done monthly. For delay, a penalty of LE 0.15 is levied for 26-31 days delay, LE 0.25 for 32-37 days and LE 0.45 for 38 days or more. Zagazig installed eight public taps, however, no fee has been charged. In case of faulty meters, which account for 10.0% of the total, the latest three months average is charged.

(c) Tariff Revenue

The water surcharge revenues for sewerage service for Zagazig are as follows:

	1985/86	1986/87	1987/88
LE	24,802.7	30,171.9	17,673.3 (as of Dec. 1987)

2.4.3 Sewerage Connection Revenue

House connections are of responsibility of the consumers and its connection costs to the adjacent pipeline network are borne by them. A typical example of connection cost breakdowns are illustrated below:

Stamp (application)	:	LE 0.35
Survey fee	:	0.30
Engineering drawing fee	:	0.30
Stamp (eng. drawing)	:	0.10
Workers' wage		
Soil street	:	0.85/m^3
Asphart street	:	5.00/m^3
Stamp (invoice)	:	0.10
Material costs		
Clay pipe	:	3.0-3.5/75cm
Cement	:	5.0/50kg
Sand	:	3.0/m^3
Gravel	:	13.0/m^3

2.4.4 Vacuum Car Rental

Zagazig has ten vacuum cars capacities and numbers of which are 4m^3 x 6 cars, 5m^3 x 2 cars and 6m^3 x 2 cars. Due to the recent development of sewer pipe network, the revenues have been gradually decreasing in this Markaz. The revenues of vacuum car rental and house connection charges together in Zagazig for the last four years are shown below:

	1983/84	1984/85	1985/86	1986/87
LE	32,163	25,381	24,331	22,416

2.5 Minyet El Qamh

2.5.1 Source of Sewerage Revenues

This Markaz also depends on three sources of revenues i.e., 1) 10.0% water surcharge, 2) house connection charge and 3) vacuum car rental.

2.5.2 Sewerage Charge

(a) Sewerage Tariff

The tariff applied in this Markaz is the same as in other Marakaz. Yet since 1985, when the new law was enacted to charge for sewerage services, it was extremely difficult for the Markaz office to collect sewerage fees from governmental offices and mosques/churches. Thus, fee collection has been made mainly from residential consumers and collection from these institutions took place in 1986/87.

(b) Collection System

Minyet El Qamh has five collection officers who are located at the Markaz office and consumers come to pay every three months. Meter checking is also carried out at three month interval. Delay payment penalties are set at LE 0.05 for 23-25 days, LE 0.55 for 26-30 days and LE 1.45 for 30 days or more. It is said that only 0.5% of consumers tend to be late and their average delay period is about two months. Public taps unlike other Marakaz do not exist. Meter counters however are problematic in this Markaz. About 60.0% of the total meters installed have broken down. The charges, in case of faulty meters, are placed by two ways either the previous three months average or 10 m^3 which is considered to be the minimum consumption for three month period.

(c) Tariff Revenue

As mentioned above, this revenue does not necessarily include payment from governmental and religious institutions. The revenues for the last
three years are as follows:

1985/86	1986/87	1987/88
LE 6,305	5,848	3,720 (as of Dec. 1987)

2.5.3 House Connection Revenue

The year of 1985/86 was the peak of house connection revenues when application for sewerage connection by consumers increased greatly. This revenue is included in vacuum car rental revenue.

2.5.4 Vacuum Car Rental

There are four vacuum cars in this Markaz. Their capacity sizes are all $3m^3$. It costs LE 0.75 for the consumer to rent each time. The revenues of vacuum car rental and house connection are as follows:

1983/84	1984/85	1985/86	1986/87
LE 6,500	7,204	8,361	6,519

From the above, the sewerage revenues of the five Marakaz for 1985/86 and 1986/87 can be summarized as follows:

	1985/86	1986/87
Bilbeis	LE 18,431	17,817
Abu Kebir	7,191	6,503
Faqus	12,558	14,378
Zagazig	49,134	52,588
Minyet El Qamh	8,361	6,519

Table XVII-1 Vacuum Car Rental Revenues, Sharqiya Governorate

	1983/84	1984/85	1985/86	1986/87
Zagazig	-	-	-	-
Bilbeis	4,700	4,270	4,921	6,916
Qenayat	-	-	-	-
Mashtul	4,350	5,174	5,811	5,204
Ibrahimia	1,600	1,942	1,785	-
Kafr Saqr	1,340	1,570	1,662	-
Abu Kebir	2,310	2,445	2,921	2,677
Minyet ElQ	6,500	7,204	8,361	6,519
Diarb Nigm	4,149	4,699	5,988	7,758
Abu Hammad	4,700	5,143	6,505	-
Huseinia	-	-	-	-
Faqus	8,300	10,202	12,558	14,378
Hihya	4,505	5,941	10,486	7,577
Total	41,764	48,590	61,008	51,029

Table XVII-2 Sewerage Connection Charge Revenues, Sharqiya Governorate

	1983/84	1984/85	1985/86	1986/87
Zagazig	32,163	25,381	24,331	22,416
Bilbeis	9,910	7,822	7,117	4,468
Qenayat	-	-	-	-
Mashtul	-	-	-	-
Ibrahimia	-	-	-	2,598
Kafr Saqr	-	-	-	1,533
Abu Kebir	-	-	-	-
Minyet ElQ	-	-	-	-
Diarb Nigm	-	-	-	8,964
Abu Hammad	-	-	-	-
Huseinia	-	-	-	-
Faqus	-	-	-	-
Hihya	-	-	-	-
Total	42,073	33,203	31,448	39,979

APPENDIX - XVIII

NEW TARIFF STRUCTURE

APPENDIX - XVIII

NEW TARIFF STRUCTURE

Table of Contents

List of Tables

1. Introduction

On 22nd December, 1987 the State Council chaired by the prime minister announced a new tariff of water supply for all governorates except Cairo, Alexandria and some border governorates in order to cover increasing production costs of water in Egypt. This announcement, in fact, reflected recommendations made by the Advisory Committee which had been established in the Ministry of Housing to investigate the appropriate water tariff structure for some time. The basic principle for this tariff change is therefore to ensure viable operation of water supply services and to improve the financial positions of the local governorates in the country.

The main features of the new tariff rate are:

(1) consumers are further broken down into more categories and new categories are created such as building and construction industries, commercial shops, tourism and welfare facilities, untreated water users, and fixed rate for public apartments.

(2) tariff increases proposed are phased over the coming five years (1987/88-1991/92).

(3) annual incremental amounts are very substantial. Incremental percentages calculated over the present rates for next five years are as follows;

	1987/88	1988/89	1989/90	1990/91	1991/92
Residential	20%	40%	60%	80%	100%
Const/Build.	30%	60%	90%	120%	150%
Industry	30%	60%	90%	120%	150%
Tourism	150%	200%	250%	300%	350%

It is expected that with these increases in tariff level, the financial status of the entities would be greatly improved and necessary operation and maintenance costs would be fully covered.

For reference, the new tariff rates are shown in the following Table XVIII-1.

For sewerage charge, the State Council decided to maintain the present level of proportional surcharge i.e., 10.0% of water bill for the next five years as new water tariff incremental is substantial.

Table XVIII-1 New Water Tariff

(Revised as of Janunary & March 1988, unit: pt/m3)

Cateogry	1987/88	1988/89	1989/90	1990/91	1991/92
Residential:					
below $30m^3$	6.0	7.0	(5.5)	(6.5)	(7.5)
above $30m^3$	6.0	7.0	8.0	9.0	10.0
Construction & Building:	13.0	16.0	19.0	22.0	25.0
Service Sector:					
Soc. Office	3.5	4.5	5.5	6.5	7.5
Club & Center	6.0	7.0	8.0	9.0	10.0
Commerce & Shop	9.0	11.0	13.0	15.0	18.0
Industry	13.0	16.0	19.0	22.0	25.0
Tourism & Welfare	25.0	30.0	35.0	40.0	45.0
Untreated Water:					
Indiv./Gov.	4.0	4.5	5.0	5.5	6.0
Canal Water	8.0	9.0	10.0	11.0	12.0
Preliminary Treat. Water*1	4.0	5.0	6.0	7.0	8.0
Treated Water:					
Gov't Factory	9.0	11.0	13.0	15.0	18.0
Local Offices	6.0	7.0	8.0	9.0	10.0
Pub. Apartment per;*2					
One Room	35.0	45.0	55.0	65.0	75.0
Two Room	45.0	55.0	65.0	75.0	90.0
Three Room	55.0	65.0	70.0	100.0	120.0
above Three Room	70.0	90.0	110.0	130.0	150.0

(Source: Ministry of Housing, March 1988)

Note: *1 This preliminary treated water is not potable, and used specially in Cairo.

*2 This is a new category created and the rate is fixed at this prices specially for the residents in public apartment.

It should be noted that the above tariff is retroactive to 1st January, 1988.

APPENDIX - XIX

LEVELING SURVEY FOR FOUR CITIES

APPENDIX - XIX

LEVELING SURVEY FOR FOUR CITIES

Table of Contents

List of Figures

List of Photos